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FROM

The state of Conn.

11 June, 1898

CORRECTIONS.

P. 98, second line from the bottom, after per cent. insert, in form.

P. 123, last line, for 127, read 129.

P. 124, sixth fertilizer analysis from the bottom of the page, before Soluble Potato Manure, insert, Hubbard's.

P. 125, sixth line from the bottom, the last figure in the line (potash guaranteed,) should be *5.0* instead of *10.0*.

P. 159, for the last paragraph on the page, substitute the following:—

The conspicuous portions of the bean flower consist of an upright petal known as the "standard;" two narrower petals, distinct, projecting forward below the standard and known as the "wings;" and two petals in the form of a closed, spirally coiled tube, occupying a position between the standard and the wings and called the "keel." (Fig. 1). At the base of the keel is the ovary or young pod surrounded by the stamens and prolonged upwards into the style. The long stamens and style are completely enclosed in and protected by the keel.

P. 194, under Carrot, for *Caroa*, read *Carota*. Eighth line from bottom of page, for *Pretoselini*, read *Petroselini*.

P. 196, seventeenth line from top of page, for *Trifolium*, read, *Trifoliorum*.

P. 214, thirteenth line from the top, for *Porouospera*, read, Peronospora.

P. 217, sixth line from bottom of page, for *compestris*, read, *campestris*.

STATE OF CONNECTICUT

TWENTY-FIRST ANNUAL REPORT

OF

The Connecticut Agricultural Experiment Station

For 1897

Printed by Order of the General Assembly

The publications of this Station are sent free to every citizen of Connecticut who applies for them. Address, The Conn. Agricultural Experiment Station, New Haven, Conn.

NEW HAVEN:
THE TUTTLE, MOREHOUSE & TAYLOR PRESS
1898

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The State of Conn.

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REPORT OF THE TREASURER.

William H. Brewer, in account with The Connecticut Agricultural Experiment Station for the fiscal year ending September 30th, 1897.

RECEIPTS.

	For 9 months.	For 3 months.	Total.
Balance from 1896,	$ 420.00		$ 420.00
State, Agr. Appr.,	7,500.00	$2,500.00	10,000.00
" Food Appr.,	1,875.00	625.00	2,500.00
United States Appr.,	5,625.00	1,875.00	7,500.00
Analyses Fees of 1896,	1,635.00	....	1,635.00
" " " 1897,	3,260.00	712.00	3,972.00
Miscellaneous,	71.00	15.90	86.90
	$20,386.00	$5,727.90	$26,113.90

EXPENDITURES.

	For 9 months.	For 3 months.	Total.
S. W. Johnson, Salary,	$ 937.50	$ 312.50	$1,250.00
E. H. Jenkins, "	1,875.00	625.00	2,500.00
W. H. Brewer, "	225.00	75.00	300.00
C. S. Green, "	450.00	100.00	550,00
V. E. Cole, "	....	23.08	23.08
W. C. Sturgis, "	1,500.00	500.00	2,000.00
T. B. Osborne, "	1,275.00	425.00	1,700.00
A. L. Winton, "	1,275.00	425.00	1,700.00
A. W. Ogden, "	1,200.00	400.00	1,600.00
G. F. Campbell, "	600.00	200.00	800.00
W. L. Mitchell, "	550.01	200.00	750.01
H. Lange, "	524.99	175.01	700.00
W. E. Britton, "	825.00	275.00	1,100.00
J. B. Olcott, "	600.00	200.00	800.00
C. J. Rice, "	450.00	150.00	600.00
V. L. Churchill, "	413.00	150.00	563.00
Labor,	590.72	352.05	942.77
Publications,	185.88	....	185.88
Postage,	107.79	30.02	137.81
Stationery,	208.78	85.27	294.05
Telephone and Telegraph.	122.82	40.22	163.04
Freight and Express,	70.58	3.25	73.83
Coal,	871.75	....	871.75
Gas,	267.59	53.45	321.04
Water,	147.00	....	147.00
Amount carried forward,	$15,273.41	$4,799.85	$20,073.26

	For 9 months.	For 3 months.	Total.
Amount brought forward,	$15,273.41	$4,799.85	$20,073.26
Chemicals and Lab. Supplies, .	1,296.40	101.41	1,397.81
Miscellaneous Supplies, . .	127.94	39.15	167.09
Fertilizers, ...	99.80	8.11	107.91
Feeding Stuffs, ...	56.14	12.00	68.14
Library and Periodicals, . .	252.09	60.38	312.47
Tools and Implements, . . .	13.80	11.90	25.70
Furniture and Fixtures, . .	36.52	2.61	39.13
Scientific Apparatus, . . .	100.07	90.20	190.27
Traveling Expenses of the Board,	25.81	2.75	28.56
" " " Staff. .	160.05	34.09	194.14
Tobacco Investigation, . . .	442.34	230.78	673.12
Field Experiments, . . .	71.15	--------	71.15
Fertilizer Sampling, . . .	259.58	2.70	262.28
Food Sampling, ...	123.57	8.47	132.04
New Street Layout, . . .	1,039.89	--------	1,039.89
Unclassified Sundries, . . .	96.05	250.65	346.70
Betterments, ...	--------	83.24	83.24
Repairs, ...	419.20	478.66	897.86
Balance to New Account, . .	-------	--------	3.14
	$19,893.81	$6,216.95	$26,113.90

As heretofore, the accounts are given for periods of nine and three months to facilitate the comparison and correlation of the two separate reports that are required to be made, to the United States, and the State of Connecticut, conforming to their different fiscal years, ending with June and September respectively. The classification of expenditures is, as far as is practicable, that which is recommended by the U. S. Secretary of Agriculture, for use by all stations of the country, and which is required for the special report to the Secretary of the Treasury, for the expenditures from the congressional appropriation.

The accounts have been duly audited by the State Auditor of Public Accounts.

Attest :

WM. H. BREWER,

Treasurer.

CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

OFFICERS AND STAFF FOR 1897.

STATE BOARD OF CONTROL.

		Term expires,
	Ex-officio.	
	HIS EXCELLENCY LORRIN A. COOKE, *President.*	
	Appointed by Connecticut State Agricultural Society:	
	S. M. WELLS, Wethersfield.	July 1, 1900
	Appointed by Board of Trustees of Wesleyan University:	
	PROF. W. O. ATWATER, Middletown.	1900
	Appointed by Governor and Senate:	
	EDWIN HOYT, New Canaan.	1898
	JAMES H. WEBB, Hamden.	1899
	Appointed by Board of Agriculture:	
Executive Committee.	T. S. GOLD, West Cornwall, *Vice-President.*	1898
	Appointed by Governing Board of Sheffield Scientific School:	
	W. H. BREWER, New Haven, *Secretary and Treasurer.*	1899
	Ex-officio.	
	S. W. JOHNSON, New Haven, *Director.*	

STATION STAFF.

Chemists.

S. W. JOHNSON, *Director.*
E. H. JENKINS, PH.D., *Vice-Dir.*
A. L. WINTON, PH.B.
T. B. OSBORNE, PH.D.
A. W. OGDEN, PH.B.
G. F. CAMPBELL, PH.B.
W. L. MITCHELL, PH.B.

Mycologist.
WILLIAM C. STURGIS, PH.D.

Horticulturist.
W. E. BRITTON, B.S.

Grass Gardener.
JAMES B. OLCOTT, South Manchester.

Stenographer and Clerk.
MISS C. S. GREEN.*

In charge of Buildings and Grounds.
CHARLES J. RICE.

Laboratory Helpers.
HUGO LANGE.
JULIUS KORN.

Sampling Agent.
V. L. CHURCHILL, New Haven.

* Till September 1st. Succeeded by Miss V. E. Cole.

ANNOUNCEMENT.

The Connecticut Agricultural Experiment Station was established in accordance with an Act of the General Assembly approved March 21, 1877, "for the purpose of promoting Agriculture by scientific investigation and experiment."

The Station is prepared to analyze and test fertilizers, cattle-food, seeds, milk, and other agricultural materials and products, to identify grasses, weeds, molds, blights, mildews, useful or injurious insects, etc., and to give information on various subjects of Agricultural Science, for the use and advantage of the citizens of Connecticut.

The Station does not undertake sanitary analyses of water.

The Station makes analyses of Fertilizers, Seed-Tests, etc., for the citizens of Connecticut, without charge, provided—

1. That the results are of use to the public and are free to publish.
2. That the samples are taken from stock now in the market, and in accordance with the Station "Instructions for Sampling."
3. That the samples are fully described and retail prices given on the Station "Forms for Description."

The officers of the Station will take pains to obtain for analysis samples of all the commercial fertilizers sold in Connecticut; but the organized coöperation of farmers is essential for the full and timely protection of their interests. Granges, Farmers' Clubs, and like associations can efficiently work with the Station for this purpose, by sending in duly authenticated samples early during each season of trade.

☞ By a recent Act of Legislature it is made the business of this Station to examine articles of food and drink on sale in Connecticut, with reference to their adulterations.

Here it may be stated that, *until further notice*, the Station will examine only such samples of food and drink as are collected by its agents or such as shall be taken under its advice, and by the methods it shall prescribe or approve.

All other work proper to the Experiment Station that can be used for the public benefit will be done without charge. Work for the private use of individuals is charged for at moderate rates. The Station undertakes no work the results of which are not at its disposal to use or publish, if deemed advisable for the public good.

Results of analysis or investigation that are of immediate general interest are published in Bulletins, copies of which are sent to each Post Office in the State, and to every citizen of the State who applies for them. The results of all the work of the Station are summed up in the Annual Reports made to the Governor.

It is the wish of the Board of Control to make the Station as widely useful as its resources will admit. Every Connecticut citizen who is concerned in agriculture, whether farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications as far as lies in its power.

☞ Instructions and Forms for taking samples, and Terms for testing Fertilizers, Seeds, etc., for private parties sent on application.

☞ Parcels by Express, to receive attention, should be *prepaid.*

☞ Letters sent to individual officers are liable to remain unanswered in case the officer addressed is absent. All communications therefore should be directed simply to the

AGRICULTURAL EXPERIMENT STATION,
NEW HAVEN, CONN.

and all remittances should be made payable to the undersigned.

☞ Station Grounds, Laboratories and Office are on Huntington Street, five minutes walk west from Whitney Avenue and 1⅝ miles north of City Hall.

☞ Huntington Street may be reached by Whitney Avenue Electric Cars, which leave the corner of Chapel and Church Streets five times hourly, viz: on the striking of the clock and at intervals of twelve minutes thereafter.

☞ The Station has Telephone connection and may be spoken from the Central Telephone Office, 118 Court Street, or from Peck & Bishop's Office in Union R.R. Depot, New Haven.

☞ The Grass Garden, in charge of Mr. James B. Olcott, is near South Manchester, five minutes walk from the line of the Manchester Electric Cars, leaving City Hall square, State Street, Hartford, every half hour. Conductors on this line can direct visitors to the Garden.

S. W. JOHNSON, *Director.*

REPORT OF THE BOARD OF CONTROL.

To His Excellency, Lorrin A. Cooke, Governor of Connecticut:

The Board of Control of the Connecticut Agricultural Experiment Station herewith submits its report for the year ending October 31st, 1897.

EXAMINATIONS OF FOOD PRODUCTS.

Eight hundred and seventeen samples of Food Products have been bought by agents of this Station in various towns and cities of Connecticut. These samples have been suitably examined with reference to the presence of adulterants by Messrs. Winton, Ogden and Mitchell. A full account of the results of this work is already in type, to appear as Part I of the forthcoming Twenty-first Annual Report of this Station.

WORK FOR THE DAIRY COMMISSIONER.

All the chemical work required by the Dairy Commissioner has been done in the laboratory of this Station, including examinations of twenty samples of butter, one hundred and ninety-two of molasses and sixty-five of vinegar.

THE FERTILIZER CONTROL.

During the months of April, May and June, Mr. V. L. Churchill, sampling agent of this Station, visited one hundred towns and villages of this State and drew five hundred and seventy-six samples of commercial fertilizers, which represented two hundred and sixty-seven of the brands that have been entered for sale within the State.

Analyses of samples of all these brands have been made in the chemical laboratory, by Messrs. Winton, Ogden and Mitchell, with the assistance of Mr. Lange.

A manuscript copy of each analysis has been sent to the manufacturer and to each dealer from whom a sample of the goods was drawn.

The Station chemists have also analyzed two hundred and eighty-one other samples of fertilizers and manurial waste-products, making the total number of fertilizer analyses five hundred and forty-eight.

The results of these fertilizer analyses have been tabulated and are in the printer's hands.

They will be issued as soon as possible, as Part II of the Twenty-first Annual Report of this Station.

OTHER CHEMICAL WORK.

In connection with vegetation experiments, the chemists have analyzed one hundred and one crops of oats and forty-eight crops of Hungarian grass, the roots, the seeds, and the stalks with leaves, separately; they have also analyzed one hundred and one crops of Hungarian grass and forty-eight crops of mixed rye and oats, all grown in pots.

To supplement experiments in the forcing-houses, the chemists have analyzed, of the tomato plant, fifty samples of roots, fifty of stalks and leaves, three of fruit and one of the entire plant; of carnations, eight samples of the blooms and forty-four of the entire plant; of radishes, six samples; and of lettuce four samples.

Two analyses has been made of the ash-ingredients in English violets, one of the blooms and one of the plants.

The chemists have also analyzed eighteen samples of milk, eight of butter, five of cream, two of honey, one of vinegar and four of feeding stuffs, not included in the foregoing statements.

Considerable work has also been done by the chemists in testing analytical methods, especially as concerns the quantitative determination of nitrogen and of potash.

SEED TESTING.

Two hundred and forty-nine samples of vegetable seeds have been tested in the interest of seedsmen and purchasers, as to their vitality and germinative power.

This important work has been carried out by Dr. Jenkins and Mr. Lange, employing the apparatus and methods recommended by a committee of the American Association of Agricultural Colleges and Experiment Stations, of which Dr. E. H. Jenkins was chairman.

STUDY OF PLANT PROTEIDS.

The study of these proteids, begun in 1889 by Dr. Osborne, has been continued by him, with the assistance of Mr. Campbell.

The proteids of certain leguminous seeds have been further investigated and the results are already prepared for the printer.

MYCOLOGICAL WORK.

The investigations of Dr. Wm. C. Sturgis during the last Station year have been principally as follows:

1. Successful experiments in preventing the prevalent mildew of lima beans, with a study of the manner in which it gains access to the young pods and of the agencies that assist its dissemination.
2. Trials of the efficiency of some fungicides in preventing the early and late blight of celery. Excessive rainfall interfered with the normal development of celery, but the trials warrant recommending a definite line of treatment.
3. Experiments to prevent the melon blight so disastrous of late. This work was rendered nearly valueless by the heavy rains.
4. Successful trials in the prevention, by Bordeaux mixture, of a fungous disease of Rhode Island Greening apples, known as "sooty spot."
5. Investigations upon an obscure disease of carnations, caused apparently by a fungus (*Fusarium*) choking the sap ducts and inducing a peculiar wilting of the plants.
6. The investigation of an apparently new disease of potatoes characterized by the sudden wilting and death of young plants.
7. A number of minor experiments, including preliminary studies upon the so-called "calico" of tobacco, the value of fir-tree oil as an insecticide, the cause of "leaf-curl" of violets and various other matters suggested by correspondence.

HORTICULTURAL AND ENTOMOLOGICAL WORK.

Dr. Jenkins and Mr. Britton, with the coöperation of the chemical department, have continued the study of the relative availability of organic nitrogen, in various forms, by vegetation experiments with rye and oats, with oats alone and with Hungarian grass. Two hundred and fifty cultures, of oats followed by Hungarian grass, grown in pots charged with natural soil, have been carried out during the spring and summer in the vegetation house built for that purpose.

The comparative availability of nitrogen in bone of different degrees of fineness, has been studied by forty-eight experiments with rye and oats and a like number with Hungarian grass, grown in cylinders sunk in the ground.

During the winter fifty cultures of tomatoes, fifty-four of radishes and twelve of carnations, in rich compost and also in a mixture of peat and coal ashes to which fertilizer chemicals had been added, were carried on in the forcing-houses to study the fertilizer requirements of these plants.

Mr. Britton has also experimented on grafting hickories and chestnuts and has begun observations on the growth of forest tree seedlings in coöperation with the Division of Forestry, of the U. S. Department of Agriculture.

The necessary Entomological work of the Station, such as the determination of species of insects sent for identification, experiments in the destruction of insect pests, and the efficiency of various insecticides, has also been done by Mr. Britton.

FIELD EXPERIMENTS.

Under the supervision of Dr. Jenkins, the three experiments on the fertilization of peach orchards which were begun in 1896, chiefly to study the effect of different amounts of potash salts and of the forms of nitrogen best adapted to the crop, have been continued.

A new series of experiments on the effects of certain fertilizers upon the quality and quantity of the tobacco crop, was begun in 1897.

In connection with these, experiments were made in curing the crop, on the stalk, with the aid of artificial heat. These experiments were nearly concluded when the barn containing the crops was destroyed by fire.

THE GRASS GARDEN.

In the grass garden at South Manchester, Mr. J. B. Olcott has continued the care and study of the large and unique collection of native and foreign turf-making grasses which under the auspices of this Station he has personally gathered from a wide range of country in the United States, Europe and Australia.

Some leading ideas in our grass studies are the following :—

1. Grasses of the same botanic species, through long periods of adaptation to various circumstances of soil, climate and treatment, have developed into varieties that differ as widely from each other as do the familiar varieties of apples, pears, strawberries, grapes and other fruits.

2. The propagation of grasses from seed so long universally practised, tends to produce, and in some cases plainly has produced, varieties that are superior in seed- and straw-yielding capacity, but inferior in succulence and nutritive quality.

3. Under properly managed grazing of cattle and especially of sheep, the grasses that make permanent pasture and firm tenacious turf have mostly been prevented from blooming, and to a greater or less degree may have lost their power to yield large and profitable crops of seed, and probably have acquired great vigor in occupying the ground and in reproducing themselves through lateral growth of their roots and rootstalks, and in producing constantly renewed and abundant supplies of tender, sweet and highly nutritious herbage.

4. Since with very few exceptions the good, cultivated forage grasses of New England have come to us from Europe, and mostly by accident, it is not improbable that a careful search in the countries where the grazing industries have been carried on most successfully and for the longest time—would be rewarded by finding varieties of grasses that are better than those commonly known here, and would furnish valuable knowledge as to the methods of profitable grass culture. Mr. Olcott inclines to the belief that he has discovered in foreign countries and now has under observation some grasses that will prove useful acquisitions to this country.

5. To test the 2500 distinct grasses that have been or now are growing in the South Manchester garden—distinct as to localities whence taken, though belonging to a few botanic species—Mr. Olcott's plan has been to propagate them chiefly from sets, rarely from seed, in pure cultures on small plots, side by side, with constant removal of weeds and with close cutting (as a rule every other day) with the lawn mower, throughout the growing season from early spring to late autumn, in imitation of sheep grazing. This process to be carried on for a term of years until the qualities of the grasses as respects vigor and tenacity of vegetative life, ability to resist or recover from adverse influences of climate and weather, and the wear and tear of constant treading, weeding and cropping, shall have been amply demonstrated and put on record. Then as the inferior sorts are gradually rejected, the better ones are given increased area, and in good time the best are to be propagated and distributed for use in lawns and pasture lands.

STATION PUBLICATIONS.

The Twentieth Report of this Station for the year 1896, a volume of four hundred and thirty pages, has been issued in an edition of twelve thousand copies, and the seven thousand copies which were at the disposal of this Station have been distributed, after satisfying our exchanges, among the farmers of Connecticut in response to applications. Less than one hundred copies remain in our hands.

By act of the last General Assembly the number of Reports which can be printed at State expense is reduced from twelve thousand to seven thousand, and none of them are to be bound with the Report of the Board of Agriculture.

Bulletin No. 124, issued in June last, in an edition of five thousand copies, eleven pages, was entitled "The Cost of Plant Food in Connecticut, Spring Months of 1897."

The remainder of the Annual Report for 1897 is now in course of preparation. The papers therein presented are written by those members of the staff whose names appear under the titles, credit being also given at the beginning of each paper to others who have shared in the work described.

This Report will be issued in several parts and each part will be mailed, as soon as printed, to those whose names are on our mailing list.

As there will be no stitched or bound copies of the complete Report for general distribution, it will be necessary for those who desire to possess the full report to save these parts as they appear. The last part issued will contain a complete index and table of contents.

CORRESPONDENCE.

During the year three thousand and thirty-nine letters and manuscript reports of fertilizer and other analyses, have been written.

MEETINGS OF THE BOARD.

During the year ending October 31st the Board of Control has held three meetings.

All of which is respectfully submitted.

WILLIAM H. BREWER, *Secretary.*

November 1st, 1897.

REPORT ON THE CHANGES IN THE EXPERIMENT STATION GROUNDS.

By WILLIAM H. BREWER, Agent for the State.

From the organization of the Experiment Station in 1877 until 1882, it occupied quarters provided for it by the Sheffield Scientific School, without any cost to the State. The State Legislature in 1882 made an appropriation to provide the Station with quarters of its own, and the Board of Control on May 13th, 1882, bought the place it has since occupied, situated on Suburban street, New Haven.

The grounds had been originally laid out and the house and barn built by Eli Whitney, Esq., for his private residence, and Suburban street had also been laid out with special reference to this place. The grounds were of irregular outline, bounded on three sides by curved lines conforming in a measure to the irregularities of elevation. As described in the deed, the boundary had thirty-four sides and angles, the sides having a total length of 1970 feet, and the area was approximately five acres.

Suburban street ran westerly from Whitney avenue, in a straight line to the easterly boundary of the property above described, which it met at nearly a right angle, and then followed the boundaries of the grounds around the southerly side in a double curve. A road had been laid out around the northerly boundary in a similar double curve, but it had never been opened for use. The residence had been built on the summit of the hill, facing easterly, and directly in line with the lower and straight portion of Suburban street, and facing the picturesque East Rock, which lies beyond and directly in front.

The straightening of Suburban street had been discussed from time to time, and the matter took active shape in 1892. On June 13th, Eli Whitney, Esq., who owned the property on three sides of the Station grounds, petitioned the city authorities for a change in the location of a portion of Suburban street. The petition was duly referred to the Committee on Streets, a layout was made substantially in accordance with the petition, the committee reported to the Common Council January 5th, 1893, and orders were passed.

This layout called for a change of location of only the eastern portion of Suburban street, and did not cut into the Station lands nor materially change its southern boundary. The plan, however, called forth criticism because it did not straighten the street.

Other maps were prepared by the City Engineer, and the matter came again before the city authorities in May and June.

There were now two or more plans before the city authorities, and on July 10th the Mayor sent a communication to the Common Council and recommended that the order already acted upon should be modified, saying that the old, crooked and forked layout was a disfigurement of the city map, and that any changes straightening the street should be made before more building was done on it.

The Board of Aldermen on August 7th ordered the Board of Public Works to cause a new layout to be made, and further action followed in August, September and October. On Nov. 6th, there was another communication from the Mayor, which resulted in an order for the city engineer to prepare new maps. In December there was another report on the matter of the Mayor's communication, and the Board of Public Works was ordered to cause a layout to be made, with directions as to what the changes should be, and that Suburban street be discontinued when the new street should be opened and accepted.

The map made in accordance with these directions is dated Jan. 2d, 1894, and Mr. Whitney sent in a petition for a new layout in accordance with this last map, which petition came duly before the authorities in July, and on September 5th the respective bodies again ordered that the Board of Public Works cause a new layout to be made for the new street.

In February, 1895, the petition of Mr. Whitney along with orders were referred to the Committee on Streets, which committee reported in April, and the aldermen and Common Council again ordered the Board of Public Works to cause a new layout to be made and report the same on or before June 3d. This order described the layout that was to be made.

Inasmuch as the new streets would cut into the Station grounds on both the northerly and southerly sides, the Corporation Counsel was instructed to appear before the General Assembly and take the necessary steps towards securing from the State of Connecticut sufficient land to allow of the passage of the new streets.

On July 17th there was a public hearing on the matter, at which the Experiment Station opposed this new layout. It objected to the expenses that would be necessary to adjust the land to the new conditions, grading, new approaches, etc., and moreover stated that damage would result to the Station property by the closing of Suburban street; that the original layout had been especially made to enhance the attractiveness of the outlook from the old residence, now the main Station building; that the view of the picturesque East Rock was in line with the street; that the buildings both in plan and position had been specially designed in reference to this frontage and view; that the proposed changes would change the street frontage to what had been the side, and that the attractiveness would be diminished and incidentally the market value of the property affected.

The changes, however, were ordered, with the proviso that Mr. Whitney was to open the street at his own expense, and settle with the Station for any actual damages that might occur to the property.

In August lengthy reports came before the city authorities, the plans were accepted and the Board of Compensation ordered to assess damages and benefits, and in September further orders were given to the Board of Public Works relating to the layout.

The orders necessitated changes in the boundary lines on three sides of the Station land. The new streets took a lunette-shaped piece of land on either side and threw between the Station grounds and the new streets portions of the old streets and also portions of Mr. Whitney's property. At its January session the General Assembly, by special resolution, approved May 23d, 1895, conceded the changes asked for and appointed William H. Brewer its agent and empowered him to settle with the City of New Haven as to damages and benefits. Mr. Whitney died in August of the same year.

After prolonged and full discussion, the agent, on January 9, 1896, entered into an agreement with the executors of Mr. Whitney's estate, according to which the estate was to pay the treasurer of the Station four hundred dollars, which sum was received January 10th, and two hundred dollars additional were to be paid if a new sewer was not built, with which the Station drains could be connected. Agreement was also made as to gas and water mains, reconstruction of fences, grading new driveways, and alteration of the boundaries to straighten the line on the east and make the northerly and southerly boundaries conform to the new streets. For this purpose, four irregular parcels of land between the Station land and the new streets and transfer rights to land which had been in the old streets were to be deeded to the Station, and the Station was to deed to the said executors one lunette-shaped parcel of land on the easterly side.

In March, 1895, the report of the Board of Compensation came before the Common Council, was accepted, the assessment laid, and this closed the matter so far as the city was concerned.

In September the new streets were named, that on the southerly side Huntington street, the northerly one Rock Avenue, and a transverse street easterly from the Station, Edgehill Road.

A new sewer for Rock Avenue was ordered in October, laid before the close of the year, and the Station connected its drains with it. The disposal of the Station sewage had been a serious problem, growing more so year by year. It had for some time been run out beyond the Station property on vacant private lands of Mr. Whitney. No satisfactory method had been devised for its disposal, and we could not hope for permission to continue the trespass after a new street had been built across the very spot. The new sewer has entirely removed this serious difficulty.

The agent appointed by the State at the previous session of the legislature, before the death of Mr. Whitney and before the action by the city had been completed, had been empowered to settle with the city, but lacked the power to settle with Mr. Whitney's executors in accordance with the terms of the agreement and according to what he considered the best interests of the Station. The General Assembly at its next session passed a resolution, approved March 1st, 1897, by which the agent was authorized to make the transfer of land agreed upon, and on March 17, 1897, deeds were executed by which four irregular-shaped parcels of land lying between the Station property and the new streets were deeded to the Station, and the agent conveyed a lunette-shaped parcel of land to the said executors. This finished the work, so far as its legal aspects were concerned.

The Station grounds are now four-sided, bounded by straight lines: northerly by Rock Avenue, 639 feet; easterly by private property, 421½ feet; southerly by Huntington street, 646½ feet; and westerly by private property, 430 feet; a total boundary of 2,137 feet; and the present area is approximately 6¼ acres.

The expenses incurred by the Station and directly incidental to these changes in streets from October 1st, 1895, to September 30, 1897, amount to $1,107.97.

Some of this was expended upon what may be considered in the end betterments; some was necessary to put the portions of the old streets that were thrown into the grounds into shape; grading had to be done; the new approaches concreted; repairs were necessitated that might have been delayed but for these changes, and various miscellaneous expenses were incurred.

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SECOND

REPORT ON FOOD PRODUCTS.

To his Excellency, Lorrin A. Cooke, Governor of Connecticut:

In presenting the second Annual Report of this Station on Adulterated Food Products, some explanatory statements may be appropriately set forth by way of preface.

The comprehensive Food Law, enacted in 1895 and now in force, requires that this Station "shall make analyses of food products on sale in Connecticut suspected of being adulterated," and "shall make an annual report to the Governor upon adulterated food products."

These duties evidently call for an investigation of "every article used as food or drink by man, horses or cattle,"* that now is, or in future may be, on sale in this State, the purity of which is not fully manifest to common observation.

This is a truly herculean labor, and the General Assembly of 1895, in view of the magnitude of the work to be accomplished, and the small fund ($2,500) annually placed at the disposal of this Station, considerately left details largely to the discretion of the Station officers.

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* "Cattle" includes "all domestic quadrupeds which serve for tillage or other labor, or as food for man."—*Century Dictionary.*

It has not been possible, under existing arrangements, to traverse, annually, more than a small section of the field. I believe, however, that all who are competent to form a correct judgment of the quality and quantity of the work performed by my associates, will admit that the Station has liberally interpreted, and fully discharged its obligations to the State.

Adulterations (falsifications, sophistications, admixtures) are of several sorts, which it is well to distinguish, viz.: *injurious*, disadvantageous to the purchaser or consumer; *fraudulent*, for purposes of deception and gain; *unhealthful* or *poisonous*, detrimental to health and life; *accidental* or *unintentional*, the result of ignorance or carelessness; *harmless*, either in kind or in degree; and *conventional*, suiting public taste and demand.

The detection of adulterations, in many cases, is easy and certain, but in many others is difficult or doubtful. It is especially difficult to prove with positive certainty the presence or absence of *all* possible or probable adulterants. Not only are new materials and methods for falsification constantly sought for, and put to use, because, so long as they are comparatively unknown and therefore unsuspected, they are likely to escape detection; but the time, skill and labor required for making a thorough search for all adulterants that are well known to be employed, commonly prohibits exhaustive investigation on our part.

For these reasons we do not usually assert that any article which has come under our scrutiny is pure or unadulterated; but we state simply and truly that it was "not found to be adulterated," or that such and such adulterants were not detected. In some cases we may even declare that certain adulterants are absent, but—since the falsifiers of food and drink make large profits by their operations, and can afford to employ the costliest scientific talent to discover new adulterants and to invent new methods for rendering the old falsifications difficult to detect,—it commonly would require more time than we can give to our investigation to attain any greater certainty or any fuller knowledge than is implied in our strictly guarded language.

To sum up, accordingly, while we are positive in testifying to the adulterations which we claim to detect, we have no call to declare that any article of food or drink is absolutely pure and unadulterated, since, in serving the public, we cannot tarry long on any single sample, but must give discreet attention yearly, to a thousand or more samples.

Some adulterations, in the present state of our knowledge, are impossible to prove. Maple sugar and maple syrup, there is little doubt, are extensively falsified. "New Vermont Maple sugar" appears abundantly in the markets very early in the year, long before "sugar weather" is established or "the sap starts" in the maple groves of northern New England. It is, I think, popularly believed that common cane (or beet) sugar is melted down with enough maple sugar, held over from a previous year, or is otherwise treated so as to give the product an alleged maple flavor. I do not doubt that a careful study would reveal the means of detecting such an imposition; but we have had, hitherto, no time to investigate this subject. Since the pure sugar of maple, sugar cane and beet is one and the same, this adulteration is comparatively harmless, and, might also appear to be justified by public demand.

The already extensive and rapidly increasing use of *antiseptics or preservatives, not evident and not known to the purchaser or consumer of foods and drinks,* has become a serious evil that demands notice here.

Antiseptics are preventives of the decay, fermentation and putrefaction of animal and vegetable substances. These processes and many other similar ones that are associated with disease in animals and plants, are due to the vegetative activity of a variety of fungi and bacteria. Antiseptics operate by suspending or destroying the life of these organisms or that of the germs out of which they develop.

Antiseptics are, accordingly, for the most part, decided poisons. In a certain dilution, with water for example, they may counteract or kill the lower, weaker organisms of fermentation, etc., without apparent injury to the higher and stronger plants and animals. Whether any one antiseptic shall operate as a harmless preservative, preventive or remedy, or as an unhealthful or even fatal poison to the consumer of food and drink containing it, depends upon the quantity and frequency of the dose.

The power of different living things, small or large, to withstand the action of antiseptics and of poisons generally, is very various, and doubtless, plants as well as animals, may gradually so adapt themselves to the attacks of poisonous substances as to acquire a considerable degree of tolerance or even of immunity.

Quantities of tea, coffee, tobacco, alcohol, opium or arsenic that would kill an infant and prostrate a strong man, to the gradually accustomed partaker become not only comparatively harmless but even for a time enjoyable.

That such tolerance and such enjoyment are, sometimes, extremely perilous, is well known though not sufficiently appreciated. The poison through long indulgence may become a necessity, its absence a distress, and either its continued use or its abandonment an absorbing menace to health and life.

A number of successful food preservatives have long been in established use, viz., sugar, alcohol, vinegar, lactic acid, salt, smoke, spices, and "sweet herbs." *All these antiseptics are at once recognizable and known by their taste or odor.* They are all commonly reckoned harmless to sound digestion and good health when used in moderation. They are all reputed to be unhealthful to certain classes of invalids, or when taken in excess.

Sugar, formerly much used in making "fruit preserves," is an unavoidable ingredient of the food of "man, horses and cattle," being contained in small proportions in the cereal grains as well as in most kinds of forage and vegetables, and abundantly present in fruits, and if, by careful selection or preparation, the animals just specified are fed with food destitute of sugar, yet sugar is inevitably formed in the digestive process, and is of necessity concerned in their nutrition.

Alcohol, the preservative of "brandy peaches," etc., is regarded by the multitude of its habitual, temperate consumers, as a beneficial stimulant and food. Used in excess, especially when undiluted with much water, it is universally conceded to be a dangerous poison.

Acetic acid, the characteristic ingredient of vinegar used in preserving pickled fruits, as well as malic, tartaric, citric and oxalic acids or their acid salts (such as cream of tartar or acid potassium tartrate), found in common fruits, and *lactic acid* (formed in the souring of milk and in the making of sauer kraut) are salutary ingredients of food when largely diluted with water and partaken in small amounts, but are powerful antiseptics and injurious to health when largely used, or taken in concentrated form. Oxalic acid, harmless in small quantities, in large doses is a deadly poison.

Salt is not formed by the animal, but, in small quantity, is essential to its life and must be supplied in or with its food. In large doses it is disagreeable and dangerous.

Smoke of burning wood is an extremely complicated mixture that owes its efficacy as a preservative to a series of substances of which *phenol* (or *carbolic acid*) and *cresol* (or *cresylic acid*) are the most familiar, both being ingredients of the creosote of wood-tar and the crude carbolic acid of coal-tar. Phenol when concentrated is extremely poisonous, but much diluted with water is harmless and a valued remedy. Phenol and cresol in small quantities, and in the forms of sulphocarbolate and sulphocresylate of potassium, are normal constituents of the urine of man and animals, being formed from the food in the digestive process.

Of the *Spices*, cloves and allspice especially are powerful antiseptics, their efficacy being due to a substance closely allied to phenol and cresol, which is known to the chemist as *eugenol*. *Thymol* in thyme, *carvacrol* in summer savory and marjoram, *estragol* in tarragon, *anethol* in anise and fennel, *apiol* in parsley, all belong to the class of phenols, all are antiseptics, and when undiluted are poisonous.

Within about twenty years several powerful antiseptics that when mixed with articles of food or dissolved in various beverages *are not recognizable by either taste or odor*, have come into very extensive and more or less surreptitious use. These are *salicylic acid*, *benzoic acid*, and *borax* or *boric* (boracic) *acid*. The first two are closely related, chemically, to phenol, and are now cheaply manufactured as coal-tar products. Methyl salicylate, a compound of salicylic acid, is the essential ingredient of oil of wintergreen and oil of birch. Benzoic acid exists in various balsams (of Tolu, Peru, Mecca), and gum resins (myrrh, storax, benzoin). It is said to occur in the oils of marjoram, cassia, cinnamon and cloves, in vanilla and sweet flag, in plums and cranberries. The keeping quality of the last-named fruit has been attributed to its content of benzoic acid. The manufacture and use of salicylic acid, as a food and drink preservative, originated in Germany, and there became very general and was reputed to be harmless. In France, however, its use has been, I believe, from the first, opposed as dangerous, and made illegal. In this country it has been, and probably still is, extensively employed in bottled and transport beer, and is now used in catsup.

Benzoic acid is dearer than salicylic acid, and the latter is much more agreeable to the taste and is reckoned to be, in general, the more powerful preservative. Both these acids are efficacious only in the free state. If neutralized or combined with an alkali they cease to be antiseptic. They are unadapted to use in milk or cream, which are curdled by very small quantities of acids.

Borax (sodium borate) and boric (boracic) acid are now extensively used because they are effective and cheap as well as odorless and their taste is easily lost or disguised when they are mixed with food.

As to the effects of the continued or frequent use of these preservatives upon the health of consumers, the testimony is conflicting.

There is no doubt that our Food Law most justly demands that "an article shall be deemed adulterated," "if it contain any antiseptic or preservative not evident and not known to the purchaser or consumer," Sec. 3, seventh. Whether the maker or seller can maintain in court of law, that one of these or any other drug or chemical preservative "is added to a food because the same is required for the protection or preparation thereof as an article of commerce in a fit state for carriage or consumption," "and not fraudulently to conceal the inferior quality thereof," (Sec. 3, c), is an important question that awaits decision.

It is evident that the laws should serve not only "for the punishment of evil doers" but also "for the praise of them that do well," and in this Report pains has been taken to announce as far as possible the names and addresses of producers, manufacturers and dealers whose goods have not been found adulterated as well as of those who have been so unfortunate as to sell fraudulent food products.

There are some falsifications which the public has long tolerated and which thus have come to be regarded as justifiable in equity, or even as "in demand by the people." Mustard, for example, has been so habitually and extensively adulterated by dilution with starchy matters and gypsum, that it sometimes is difficult to find it, even at the apothecary's, with strength enough to make an efficient mustard plaster for medical use.

Again, this kind of adulteration and the lying statements by which it has been forced on the public, have so habituated people to poor articles and low prices, that purchasers of the recent generations probably do not know, in many cases, what genuine goods are and do not realize what waste of money as well as loss of satisfaction there is in buying so-called "cheap" wares, for which, considering the real value of the articles, they actually pay an exorbitant price.

Merchants who are reckless of everything but their own immediate gain, only keep in store and diligently work off on their customers whatever yields them the largest profits, while honest dealers who desire to do the fair thing, are perhaps virtually obliged to sell adulterated goods or quit the business, and, in fact, may have no means of knowing whether or not the articles they handle are genuine or as represented.

That the public is rather indifferent to the prevalence of food adulteration might appear to be indicated by the fact, that, so far as the writer is aware, no prosecutions have been made for violation of the Food Law of 1895. But the law, in section 8, protects those who *unwittingly* deal in adulterated wares and, in section 3, makes reservations as to adulteration and misbranding, which, if proper in themselves, greatly tend to render prosecutions difficult, costly and uncertain. Furthermore the execution of the law is obligatory on no one, but is left to the discretion of grand jurors, prosecuting attorneys and private citizens. The citizens of Connecticut, who are either producers or consumers of butter, vinegar, or molasses, are under the protection of special laws whose violations, whether done wittingly or unwittingly, are prosecuted and whose penalties are enforced, as prescribed duties, by the Dairy Commissioner.

Citizens should not forget that the legislative enactment which is not duly enforced, soon becomes a dead letter, and as such tends to bring laws and lawgivers into disrepect and contempt.

It may well be that the free publication and circulation of the simple facts that such and such foods and drinks are thus and so adulterated, and that A. & B. have sold and are offering for sale this and that falsified article, will in time effectually check the demand for and commerce in adulterated goods. Such has been the fact in respect to fertilizers, which for nearly fifty years have been a more and more considerable and a frequently adulterated article of commerce in the United States. During the last twenty years, the Connecticut Agricultural Experiment Station, in accordance with the Act establishing it, has annually made and published analyses of every brand of fertilizer made, sold or offered for sale, in the State, that could be collected by its special agents. During this time, the adulterated or fraudulent fertilizers that, for twenty-five years previously, were common in our markets, have practically disappeared, and, as respects them, the intelligent farmer has been efficiently protected from deception and fraud, although, so far as I am informed, not a single violation of the law has been prosecuted by a consumer of fertilizers.

Very respectfully yours,

S. W. Johnson, *Director.*

The Connecticut Agricultural Experiment Station,
New Haven, July 31st, 1897.

THE CONNECTICUT FOOD LAW.

CHAPTER CCXXXV.

Public Acts, January Session, 1895.

An Act regulating the Manufacture and Sale of Food Products.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

Manufacture or sale of misbranded or adulterated food.

Section 1. It shall be unlawful for any person, persons, or corporation within this state to manufacture for sale, offer, or expose for sale, have in his or their possession for sale, or to sell, any article of food which is adulterated or misbranded within the meaning of this act.

Term food defined. Term misbranded defined.

Sec. 2. The term food, as used in this act, shall include every article used for food or drink by man, horses, or cattle. The term misbranded, as used in this act, shall include every article of food and every article which enters into the composition of food, the package or label of which shall bear any statement purporting to name any ingredient or substance as not being contained in such article, which statement shall be untrue in any particular; or any statement purporting to name the substance or substances of which such article is made, which statement shall not give fully the names of all substances contained in such article in any measurable quantity.

When an article shall be to be adulterated.

Sec. 3. For the purposes of this act, an article shall be deemed adulterated:

First, if any substance or substances be mixed or packed with it so as to reduce or lower or injuriously affect its quality or strength;

Second, if any inferior substance or substances be substituted wholly or in part for the article;

Third, if any valuable constituent of the article has been wholly or in part abstracted;

Fourth, if it be an imitation of or sold under the name of another article;

Fifth, if it is colored, coated, polished, or powdered whereby damage is concealed, or if it is made to appear better or of greater value than it is;

Sixth, if it contains poisonous ingredients which may render such article injurious to the health of a party consuming it, or if it contain any antiseptic or preservative not evident and not known to the purchaser or consumer;

Seventh, if it consists, in whole or in part, of a diseased, filthy, decomposed, or putrid substance, either animal or vegetable, unfit for food, whether manufactured or not, or if it is in any part the product of a diseased animal, or of any animal that has died otherwise than by slaughter;

Provided, that an article of food product shall not be deemed adulterated or misbranded within the meaning of this act in the following cases:

(*a*) In the case of mixtures or compounds which may be now or from time to time hereafter known as articles of food under their own distinctive names, and not included in definition fourth of this section;

(*b*) In the case of articles labeled, branded or tagged, so as plainly or correctly to show that they are mixtures, compounds, combinations, or blends;

(*c*) When any matter or ingredient is added to a food because the same is required for the protection or preparation thereof as an article of commerce in a fit state for carriage or consumption and not fraudulently to increase the bulk, weight or measure of the food or to conceal the inferior quality thereof;

(*d*) When a food is unavoidably mixed with some extraneous matter in the process of collection or preparation.

Connecticut Agricultural Experiment Station to make analyses.

SEC. 4. The Connecticut Agricultural Experiment Station shall make analyses of food products on sale in Connecticut suspected of being adulterated, at such times and places and to such extent as it may determine, and may appoint such agent or agents as it deems necessary; who shall have free access, at all reasonable hours, for the purpose of examining, into any place wherein it is suspected any article of food adulterated with any deleterious or foreign ingredient or ingredients exists, and such agent or agents upon tendering the market price of said article may take from any person, firm or corporation samples of any article suspected of being adulterated as aforesaid, and the said station may adopt or fix standards of purity, quality, or strength when such standards are not specified or fixed by statute.

Notice to prosecuting officers.

SEC. 5. Whenever said station shall find by its analysis that adulterated food products have been on sale in the state, it shall forthwith transmit the facts so found to a grand juror or prosecuting attorney of the town in which said adulterated food product was found.

SEC. 6. The said station shall make an annual report to the governor upon adulterated food products, in addition to the reports required by law, which shall not exceed one hundred and fifty pages, and said report may be included in the report which said station is already authorized by law to make, and such annual reports shall be submitted to the general assembly at its regular session. **Report.**

SEC. 7. To carry out the provisions of this act, the additional sum of twenty-five hundred dollars is hereby annually appropriated to said Connecticut Agricultural Experiment Station, which sum shall be paid in equal quarterly installments to the treasurer of the board of control of said station, upon the order of the comptroller, who is hereby directed to draw his order for the same. **Appropriation.**

SEC. 8. Any person who, either by himself, his agent, or attorney, with the intent that the same may be sold as unadulterated, adulterates any food products for man, or horses, or cattle, or knowing that the same has been adulterated, offers for sale or sells the same as unadulterated, or without disclosing or informing the purchaser that the same has been adulterated, shall be fined not more than five hundred dollars, or imprisoned not more than one year. **Penalty.**

SEC. 9. No action shall be maintained in any court in this state on account of any sale or other contract made in violation of this act. **Action not to be maintained on illegal sale.**

SEC. 10. All acts and parts of acts inconsistent herewith are hereby repealed.

Approved, June 26th, 1895.

DUTIES OF THE STATION UNDER THE FOOD LAW.

The fourth, fifth and sixth sections of the foregoing act lay certain duties upon this Station as follows:

1st. To make analyses of food products suspected of being adulterated.

2d. Whenever it shall find by its analysis that adulterated food products have been on sale, it shall forthwith transmit the facts so found to a prosecuting officer in the town where the adulterated food was found.

3d. The Station shall make an annual report.

The law also provides that the Station may adopt or fix standards of purity, quality, or strength, when such standards are not specified or fixed by statute.

SAMPLES COLLECTED BY THE STATION.

During the year beginning August 1st, 1896, authorized agents of this Station visited eighteen cities and villages of Connecticut for the purpose of buying samples of food products for examination.

These places are distributed as follows:

Litchfield County	2	places
Hartford "	2	"
Windham "	2	"
New London "	2	"
Middlesex "	1	"
New Haven "	5	"
Fairfield "	4	"
Total	18	"

By this means there have been secured 817 samples of food products of the following kinds or names:

Coffee	73	samples.
Pepper, black	52	"
" white	8	"
" cayenne	30	"
Mustard	7	"

Ginger	18	samples.
Allspice	25	"
Cinnamon	41	"
Cloves	35	"
Nutmeg	6	"
Mace	1	"
Sage	2	"
Marjoram	1	"
Poultry seasoning	1	"
Pickles	1	"
Worcestershire sauce	1	"
Catsup	46	"
Chili sauce	1	"
Confectionery	30	"
Honey	1	"
Maple syrup	3	"
Molasses	7	"
Sausage	42	"
Head cheese	2	"
Codfish	11	"
Oysters	75	"
Mince meat	5	"
Olive oil	81	"
Milk	211	"
Total	817	"

A portion of these, being duplicate samples, were not examined and the study of some others is not completed. The results of 756 examinations are given in the following pages.

In order that the results of our work might fairly represent the average condition of our markets, it has been the aim to get as many brands of each food product as possible, without specially selecting the cheaper grades.

For the most part food products have been selected which were different in kind from those discussed in the previous report.

The chemical examination of the samples noticed in the following pages has been made by Messrs. Winton, Ogden and Mitchell, chemists of this Station, the microscopic examinations wholly by Mr. Winton.

In every case where certain proof of adulteration was found, the facts, as required by the law, have been forthwith transmitted to a grand juror or other prosecuting officer of the town or borough where the adulterated food products were sold.

SAMPLES COLLECTED BY THE STATE DAIRY COMMISSIONERS.

The office of Dairy Commissioner was established by an act of the General Assembly, approved April 3, 1886. By this and supplementary acts the commissioner was charged with the enforcement of laws regulating the sale of three articles, viz., butter, vinegar and molasses.

The first Commissioner, finding difficulty in getting suspected butter examined elsewhere, applied to this Station for aid, which was promptly given, and from the beginning, all the chemical work required by him and his successors in office has been done by this Station gratuitously and testimony given in court as required.

The number of samples thus examined for the Dairy Commissioners is as follows:—

FOOD SAMPLES EXAMINED FOR DAIRY COMMISSIONERS FROM JUNE, 1886, TO AUGUST, 1897.

	J. B. Tatem.*	G. D. Winslow.	C. S. Burlingame.	J. B. Noble.†
Butter,	28	26	7	23
" imitation	95	87	8	2
Molasses,	67	--	41	124
" adulterated	27	--	10	58
Cane Sugar Syrups	--	--	--	16
Maple Syrup,	7	--	--	--
" " adulterated	4	--	--	--
Vinegar	140	--	--	88
Cream	--	--	--	3
	368	113	66	314

During the twelve-month covered by this Report there have been examined for the Commissioner twenty samples of butter, sixty-five samples of vinegar and one hundred and ninety-two samples of molasses and syrups which are separately considered on pp. 61 to 64.

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* Two terms.

† Term unexpired.

EXAMINATION OF FOOD PRODUCTS COLLECTED BY THE STATION.

COFFEE.

By A. L. Winton.

The subject of coffee and its adulteration was discussed at some length in the Food Report for 1896, p. 52.

Twenty-six samples of unground and 45 of ground coffee have been examined during the year ending July 31, 1897.

Unground Coffee.—Of the twenty-six samples collected two were adulterated, as follows:

Station No.	Dealer.	Price per ½ pound.	Adulterants.
7087	J. H. Dore, 765 Grand Ave., New Haven.	13 cts.	Chicory, 32%.
7359	A. A. Trudeau, 931 Main St., Willimantic.	13 cts.	Imitation coffee, peas.

The sources and cost of the 24 samples of coffee bean not found to be adulterated are named in Table I.

Table I.—Coffee Bean not found Adulterated.

Station No.		Dealer.	Price per half pound, cents.
7105	*Bridgeport.*	Richards & Schmidt, 1010 Main St.	13
7120		C. Russell & Co., 335 Main St.	15
7122		R. T. Whiting, 345 Main St.	15
7115		Carten Tea Co., 529 Main St.	15
7110		China and Japan Tea Co,, 820 Main St.	13
7297	*Hartford.*	Kingsley & Co., 436 Asylum St.	15
7259	*Meriden.*	Russell Bros., cor. Main and Colony Sts.	13
7271	*New Britain.*	Boston Branch Grocery, 238 Main St.	15
7263		Home Tea Co., 460 Main St.	15
7085	*New Haven.*	Coe & Fields, 422 State St.	13
7076		L. Frank, 26 Congress Ave.	13
7083		Johnson & Bro., 411 and 413 State St.	14
7077		B. Jacobs, 22 Congress Ave.	15
7072		L. Goldbaum, 177 Congress Ave.	15
7080		Edw. E. Hall, 770 Chapel St.	19
7075		D. M. Welch, cor. Congress Ave. and Commerce St.	13
7089		708 Grand Ave	17
7190	*Norwalk.*	Finney & Benedict, 41 Wall St.	15
7239	*Norwich.*	Hong Kong Tea Co., 210 Main St.	15
7241		G. A. Ray, cor. Water and Shetucket Sts.	13
7183	*So. Norwalk.*	Chas E. Seymour, 33 Washington St.	15
7169	*Waterbury.*	Union Pacific Tea Co., 24 Bank St.	13
7384	*Willimantic.*	H. C. Hall, 1. Union St.	15
7378		C. R. Hubbard, 22 North St.	15

Ground Coffee.—Of the 45 samples collected, 6 were not found adulterated. The names of dealers from whom they were obtained and the prices paid are given in Table II.

TABLE II.—GROUND COFFEE.

Station No.		Dealer.	Price per half pound, cents.
7293	*Hartford.*	Barrows & Thalheimer, 525 Main St.	13
7257	*Meriden.*	H. E. Bushnell, 79 W. Main St.	13
7458	*New Haven.*	A. B. Stevens, 61 Broadway	12
7215	*New London.*	T. W. Potter, 72 State St.	15
7390	*Willimantic.*	Grand Union Tea Co., 725 Main St.	13
7368		Burt Thompson, 798 Main St.	13

The other 39 samples were found to be adulterated. The names and addresses of the dealers, the prices per half pound and the adulterants found are given in Table III, page 17.

The price per half pound was quite uniformly 13 cents (25 cents per pound). In two cases it was 15 cents and in three cases 10 cents.

The adulterants detected were peas, chicory, wheat or rye, "imitation coffee" (brown lumps made from wheat middlings to resemble coarsely crushed roasted coffee) and "pellets" (of pea hulls and middlings resembling roasted coffee).

Date Stone Coffee.—A sample of a coffee substitute, recently sent to this Station without any particulars as to its manufacture and sale, proved by microscopic examination and chemical analysis to consist of date stones ground and apparently roasted. Dates are used in considerable quantity in confectionery and it would appear that the stones are utilized for "coffee."

The chemical analysis of the date stone coffee is given below, with analyses by Storer of stones from light and dark dates for comparison:*

	Date Stone Coffee.	Stones from light dates (Sugar cured).	Stones from dark dates (Molasses cured).
Water	5.52	7.71	10.83
Ash	1.75	1.05	1.02
Albuminoids	6.69	5.16	5.75
Fiber	15.84	24.07	22.06
Nitrogen free-extract	59.00	53.06	52.29
Fat	11.20	8.95	8.05
	100.00	100.00	100.00

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* Bussey Inst. Bul., vol. 1, 1874–'76, p. 375.

TABLE III.—ADULTERATED GROUND COFFEE.

Station No.		Dealer.	Price per ½ pound, cts.	Adulterants.
7108	*Bridgeport.*	Centennial Tea Co., 856 Main St.	13	Pellets,* Chicory.
7114		Coe & White, 560 Main St.	13	Peas.
7119		The Great Atlantic and Pacific Tea Co.	13	Pellets,* Chicory.
7107		Lochart, cor. Main and Grand Sts.	13	Peas, Chicory.
7117		Chas. H. Reid, 476 Main St.	13	Pellets,* Chicory.
7116		Union Pacific Tea Co., 495 Main St.	13	Peas, Wheat or Rye, Chicory.
7137	*Derby.*	Boston Tea Co., 40 Elizabeth St.	10	Chicory.
7288	*Hartford.*	Boston Branch Grocery, 271 Main St.	13	Peas, Chicory.
7290		Durfey's Tea and Coffee House, 375 Main St.	13	Peas, Chicory.
7295		Family Grocery and Provision Co., 587 Main St.	13	Peas, Rye.
7292		The Great Atlantic and Pacific Tea Co., 427 Main St	13	Pellets,* Chicory.
7262	*Meriden.*	Centennial American Tea Co., 45 E. Main St.	13	Pellets,* Chicory.
7261		Grant's Tea Store, cor. State and Main Sts	13	Peas, Imitation Coffee,* Chicory.
7255		A. V. Griffin, 62 West Main St.	13	Peas, Chicory.
7265	*New Britain.*	Union Tea Co., 425 Main St.	13	Peas, Chicory.
7078	*New Haven.*	Lewis D. Chidsey, cor. Church and George Sts.	15	Imitation Coffee.*
7086		D. S. Cooper, 470 State St.	13	Peas, Chicory.
7074		M. C. Dingwall, 66 Congress Ave.	10	Imitation Coffee,* Chicory.
7090		Grand Union Tea Co., 497 State St.	13	Peas, Chicory.
7082		The Great Atlantic and Pacific Tea Co., 386 State St	13	Pellets,* Chicory.
7073		J. H. Kearney, 74 Congress Ave.	13	Peas, Chicory.
7410		Kohn Bros., 55 George St.	13	Wheat or Rye, Chicory.
7081		Elmer E. Nichols, 380 State St.	13	Imitation Coffee.*
7084		Russell Bros., 418 State St.	10	Imitation Coffee,* Chicory.
7405		Savings Bank Grocery, 377 Congress Ave.	13	Peas, Chicory.
7071		Rob't M. Stevens, cor. Congress Ave. and Cedar St.	13	Peas, Chicory.
7079		Thomas' Tea Store, 859 Chapel St.	13	Peas, Imitation Coffee,* Chicory.
7214	*New London.*	Grand Union Tea Co., 88 State St.	13	Peas, Chicory.
7212		A. M. Stacey, 123 State St.	13	Peas, Imitation Coffee,* Chicory.
7207		Thomas & Gumble, 437 Bank St.	13	Peas, Imitation Coffee,* Chicory.
7194	*Norwalk.*	The Great Atlantic and Pacific Tea Co., 41 Main St.	13	Pellets,* Chicory.
7233	*Norwich.*	J. A. Stoddard, 100 Franklin St.	13	Peas Chicory.
7188	*So. Norwalk.*	Samuel Comstock, Jr., 72 Main St.	13	Peas, Chicory.
7150	*Waterbury.*	American Tea Co., 42 S. Main St.	13	Imitation Coffee,* Chicory.
7162		Dillon's Cash Grocery, 45 E. Main St.	13	Peas, Chicory.
7158		The Great Atlantic and Pacific Tea Co., 29 E. Main St.	13	Pellets,* Chicory.
7156		H. A. Merrill, 266 N. Main St.	13	Peas, Chicory.
7166		Waterbury Cash Grocery, 165 Bank St.	13	Peas, Chicory.
7358	*Willimantic.*	Frank Larabee, 16 Church St.	13	Peas, Chicory.

* See explanation on page 16.

EXAMINATION OF PEPPER.

By A. L. Winton.

Black Pepper.

Particulars with regard to the nature of black pepper, its adulteration, the methods for detecting adulteration and the examination of samples purchased in Connecticut in 1895–96, are given in the Report for 1896, beginning on page 32.

Standard of Pure Black Pepper.—Black pepper should contain:—

Ether extract (dried at 100° C.) not less than	6.5	per cent.
Fiber not more than	16.0	"
Ash " "	6.5	"
Sand " "	2.0	"

*Pepper sold in bulk packages.**

During the present year 45 samples sold in bulk have been examined. Twenty-seven were pure or above standard. The names of the dealers and the prices paid per quarter-pound for these samples were as follows:

Table IV.—Pepper sold in Bulk, Pure or above Standard.

Bridgeport.—Centennial Tea Co., 856 Main St., 5¢†.—R. T. Whiting, 345 Main St., 8¢.—C. Russell & Co., 335 Main St., 8¢.—China & Japan Tea Co., 820 Main St, 5¢—Richards & Schmidt, 1010 Main St., 5¢.—Chas. H. Reid, 476 Main St., 8¢.

Hartford.—John Sloan & Co., 319 Asylum St., 9¢.—Cady & Lombard, 69 Albany Ave., 10¢.—Boston Branch Grocery, 271 and 273 Main St., 7¢.—Kingsley & Co., 436 Asylum St., 10¢.—Family Grocery & Prov. Co., 587 Main St., 5¢.

New-Britain.—Boston Branch Grocery, 238 Main St., 10¢.

New Haven.—Fred. A. Basserman, 627 Grand Ave., 7¢.—Savings Bank Grocery, 377 Congress Ave., 5¢.—H. M. Tower, 379 Congress Ave., 7¢.—S. Lapido, 760 Grand Ave., 6¢.

New Milford.—Wesley Northrop, 5¢.

New London.—Thomas & Gumble Grocery, 437 Bank St., 5¢.—A. M. Stacey, 123 State St., 10¢.—T. W. Potter, 72 State St., 7¢.

Norwich.—J. A. Stoddard, 100 Franklin St., 10¢.—G. A. Ray, Cor. Water and Shetucket Sts., 5¢.

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* Usually paper bags, not bearing the name of the grinder or wholesale dealer.

† Quarter pound price, 5 cents.

So. Norwalk.—Chas. E. Seymour, 33 Washington St., 10¢.—Samuel Comstock, Jr., 72 Main St., 8¢.

Waterbury.—Dillon's Cash Grocery, 45 E. Main St., 7¢.—Waterbury Cash Grocery, 165 Bank St., 10¢.

Willimantic.—C. R. Hubbard, 22 North St., 10¢.

The following three samples contained cayenne, but the presence of other foreign material was not detected, although pepper shells may have been present :

Station No.	Dealer	Non-volatile ether extract.*	Fiber.	Ash.
7331	H. J. Case, 433 Main St., Hartford..........	7.60	10.11	3.92
7339	Hills & Co., 368 Asylum St, Hartford......	7.66	14.70	4.38
7321	Woodward & Co., 174 Asylum St., Hartford	7.75	11.76	4.65

Descriptions of 15 adulterated samples are given in Table V, page 20. Percentages printed in heavy-face type are abnormal and never found in pure pepper.

In noting the nature of adulterants, the seed or the article is named from which the adulterant is derived. It is not always possible to state positively the particular product used. For example : where wheat starch and wheat tissue were identified, wheat is mentioned as the adulterant without attempting to say whether wheat middlings, wheat flour or wheat bran was used.

Samples Nos. 7258 and 7452 contained cayenne and would have been classed with the three samples above described, but the high percentage of fiber and, in the case of No. 7452, of ash, point to adulteration with pepper shells.

The chief adulterant in Nos. 7438, 7459 and 7442, judged by its microscopic characters, appeared to be olive stones. Sample No. 7417 contained among other foreign materials, ground mustard hulls, a preparation which we have not encountered before in Connecticut, but which was formerly extensively sold for mixing with pepper, under the trade name of "H. P. D." ("Hot Pepper Dust.")

The other adulterants detected were buckwheat hulls, charred cocoanut shells, various wheat products and fruit stones or nut shells.

Pepper in Sealed Packages with Name of the Wholesaler.

Five samples of pepper in sealed packages were examined and not found adulterated. They were as follows. The cost price per quarter pound is given with each : See p. 21.

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* Piperine and resin.

TABLE V.—ADULTERATED BLACK PEPPER SOLD IN BULK.

Station No.	Dealer.	Price per ¼ pound. Cents.	Adulterants.	Non-volatile* ether extract.	Fiber.	Ash.
7138	*Derby.*—Boston Tea Co., 40 Elizabeth St.	7	Wheat.	**2.36**‡	15.96	3.90
7294	*Hartford.*—Barrows & Thalheimer, 525 Main St.	8	Buckwheat, Cayenne.	**5.50**	**19.70**	4.42
7504	E. M. Palmer. 124 Albany Ave.	10	Charred cocoanut shells, Wheat, Cayenne.	**4.08**	13.93	2.65
7258	*Meriden.*—H. E. Bushnell, 79 W. Main St.	10	Cayenne. Probably Pepper shells.	7.27	**16.75**	4.85
7260	Russell Bros., cor. Main and Colony Sts.	10	Buckwheat hulls, Cayenne.	6.98	**16.85**	5.07
7266	*New Britain.*—Union Tea Co., 425 Main St.	8	Buckwheat.	7.38†	9.10	4.50
7438	*New Haven.*—Graff & McKay, 51 Greene St.	10	Fruit stones or nut shells, Cayenne.	**5.94**	**23.55**	**7.80**
7466	John T. Pohlman, 140 Dixwell Ave.	10	Cocoanut shells, Wheat.	**6.23**	**16.87**	**6.75**
7432	L. Schmidt, 121 Hamilton St.	8	Cocoanut shells, Starchy matter.	**5.10**	15.30	**8.37**
7459	A. B. Stevens, 61 Broadway.	10	Fruit stones or nut shells, Cayenne.	**5.93**	**24.21**	6.47
7442	Conrad Weiss, 485 Chapel St.	10	" " " " " "	**5.62**	**25.80**	**6.57**
7452	D. M. Welch, 28 Congress Ave.	6	Cayenne. Probably Pepper shells.	7.38	**16.88**	**7.17**
7417	Grocery, 794 Grand Ave.	8	Charred matter, Cocoanut shells, Mustard hulls, Wheat, Cayenne.	**4.82**	**18.34**	4.15
7191	*Norwalk.*—Finney & Benedict, 41 Wall St.	10	Buckwheat, Cayenne.	7.09	**16.35**	5.32
7240	*Norwich.*—Hong Kong Tea Co., 210 Main St.	10	Buckwheat.	**5.48**	**18.28**	**7.18**

* Piperine and resin. † No crystals of Piperine.
‡ Full-face figures indicate percentages which are not found in pure pepper.

E. R. Durkee & Co.'s XXX Pepper, New York. Warranted pure. Sold by Paul Jente & Bro., Broadway, New Haven. 8¢.

Singapore Black Pepper. Packed by E. E. Hall & Son, New Haven, Conn.

Absolutely pure Black Pepper, Justice Mills. Sold by Harry Leigh, 354 State St., New Haven. 8¢.

Slade's Pepper, absolutely pure. Sold by C. H. Russell, 383 Main St., Hartford. 5¢.

Stickney & Poor's Absolutely Pure Pepper. Sold by T. W. Kimlin, New Milford. 10¢.

White Pepper.

Of the five samples examined four were not found adulterated. They were bought at the following places.

No. 7140. Grand Union Tea Co., 237 Main St., *Derby*. No. 7291. Durfey's Tea and Coffee House, 375 Main St., *Hartford*. No. 7855. Edw. E. Hall & Son, *New Haven*. No. 7156. H. A. Merrill, 266 N. Main St., *Waterbury*.

One sample, No. 7156, bought of A. V. Griffin, 63 W. Main St., *Meriden*, was adulterated with rice and cayenne.

Cayenne Pepper.

Nature of Cayenne.—Several species of the genus *Capsicum* yield peppers or "chillies," or "paprikas," which are valued because of their pungent qualities.

The condiment which in the United States and England is known as cayenne or red pepper, consists usually of the small fruits of *Capsicum fastigiatum* Bl., picked when ripe and ground entire. Our supply comes chiefly from Zanzibar and Sierra Leone. Bombay, Madras and various other inferior peppers, known in the trade as "capsicums," are used to adulterate the African products or as substitutes.

Capsicum annuum L. (to which species our garden peppers belong), is extensively grown in Hungary, and almost all the cayenne pepper (paprika) of Germany and Austria is obtained from the fruit of this plant.

During 1894 the imports of cayenne pepper into the United States amounted to 581,892 pounds, and during 1895 to 557,650 pounds.

Zanzibar cayenne was quoted June 21st, 1897, at 11 cents and "capsicums" at 6½ cents per pound.

Standard of Cayenne Pepper.—The purest samples of cayenne examined at this Station have contained

Ash	4.5 to 8.0 per cent.
Non-volatile ether extract more than	16.0 "

Adulteration of Cayenne.—A variety of cereal products, of woods, etc., are used for adulterating cayenne, as will be seen by referring to Table VII. Oftentimes the mixtures are dyed red.

EXAMINATION OF SAMPLES FROM THE CONNECTICUT MARKET.

Thirty samples bought by our agents, in bulk, have been chemically and microscopically examined.

Method of Examination.—The adulterants of vegetable origin were detected by the microscope. In order to confirm the microscopic evidence, determinations were made of non-volatile ether extract (which consists of oil, "capsicin," coloring matter, etc.), by drying two grams of the material over sulphuric acid, extracting with absolute ether and weighing the extract dried at 100° C.

Of the samples collected by our agents, 12 were found to be adulterated. (See Tables VI and VII.) The adulterants found were buckwheat middlings, corn meal and other corn by-products, wheat middlings, red sandal wood and coloring matters.

In the samples not found adulterated the percentage of ash ranged from 5.25 to 8.00. Four of the adulterated samples contained less than 4.5 and one more than 8.0 per cent. of ash.

The highest percentage of non-volatile ether extract in any of the samples found by the microscope to be adulterated was 15.32. The adulterant in this particular sample, No. 7457, was, however, buckwheat middlings, which contains 7 or 8 per cent. of fat, and therefore would not reduce the percentage of ether extract as much as would the same amount of some material containing less fat, like wheat middlings.

Sample No. 7422 consisted almost entirely of buckwheat middlings colored a brilliant red. In No. 7428 there was a large amount of red sandal wood, or "saunders" wood, as it is often called, a dye wood which is quoted at 2¾ cents per pound at wholesale. Judged by the percentages of non-volatile ether extract, the amount of adulteration in the samples examined ranges from 10 to 90 per cent.

TABLE VI.—CAYENNE, NOT FOUND ADULTERATED, SOLD IN BULK.

Station No.	Dealer.		Price paid per ¼ pound, cents.	Ash.	Non-volatile ether extract.
7491	*Hartford.*	Empire Cash Grocery, 94 Albany Ave	8	5.35	17.50
7320		Woodward & Co., 174 Asylum St	10	6.80	18.48
7326		Boston Branch Grocery, 271 Main St.	9	6.23	17.35
7332		H. J. Case, 433 Main St.	15	7.40	17.38
7336		Hills & Co., 368 Asylum St	13	7.92	18.75
7488		Chas. A. Post, 709 Main St.	10	6.10	16.63
7483		Allen Bros., 132 Main St.	12	8.00	16.60
7482		A. H. Tillinghast, 91 Main St.	10	7.00	17.70
7498		E. M. Palmer, 124 Albany Ave.	10	5.32	18.40
7473		C. H. Russell, 383 Main St.	5	6.45	16.81
7460	*New Haven.*	A. B. Stevens, 61 Broadway	10	5.50	19.10
7448		H. M. Tower, 379 Congress Ave.	7	....	17.68
7443		Conrad Weiss, 485 Chapel St.	10	5.80	19.88
7467		John T. Pohlman, 140 Dixwell Ave.	10	5.95	18.08
7391	*Norwalk.*	W. & E. Osterbanks, 53 Main St.	12	5.85	16.38
7372	*Willimantic.*	Burt Thompson, 798 Main St.	12	5.25	18.82
7366		S. E. Amidon, 877 Main St.	10	6.15	16.36
7360		A. A. Trudeau, 931 Main St.	9	5.57	19.20

TABLE VII.—ADULTERATED CAYENNE SOLD IN BULK.

Station No.	Dealer.		Price per ¼ pound, cents.	Adulterants.	Ash.	Non-volatile ether extract.
7478	*Hartford.*	Copeland Grocery, 56 Pleasant St.	7	Red Sandal Wood, Corn Meal	**3.17***	**7.10**
7418	*New Haven.*	Grocery, 794 Grand Ave.	10	Starchy Matter (probably Corn)	**3.50**	**10.70**
7422		S. Lapido, 760 Grand Ave.	10	Buckwheat, Red Dye	6.92	**9.90**
7413		Kohn Bros., 55 George St.	10	Corn Meal	**3.67**	**8.30**
7457		D. M. Welch, 28 Congress Ave.	9	Buckwheat	**8.05**	**15.32**
7425		F. A. Bassermann, 627 Grand Ave.	9	Wheat	7.25	**11.88**
7436		Graff & McKay, 51 Greene St.	10	Wheat, Red Woody Matter	**15.50**	**12.50**
7430		L. Schmidt, 121 Hamilton St.	20	Wheat	7.82	**7.18**
7395	*So. Norwalk.*	Brown & Wilcox, 70 Washington St.	12	Some Corn Product	**4.10**	**8.95**
7354	*Willimantic.*	Frank Larabee, 16 Church St.	11	Wheat, Buckwheat	6.67	**9.08**
7374		Purinton & Reade, 707 Main St.	13	Buckwheat, Red Dye	6.92	**8.20**
7387		H. C. Hall, 17 Union St.	13	Wheat, Red Woody Matter	5.05	**9.80**

* Figures in heavy type indicate percentages not found in Standard Cayenne.

CLOVES.

By A. L. Winton.

Nature.—Cloves are the flower buds of a small tree (*Caryophyllus aromaticus* L.). a native of the Molucca Islands, but now extensively cultivated in the Phillipines, the Sunda Islands, Southern India, Zanzibar and the neighboring islands, the Antilles, and tropical South America. The tree blooms twice a year, in June and in December. The buds are either picked by hand, or beaten from the tree with reeds and collected on cloths beneath. They are usually dried in the sun, during which process the color changes to brown.

The valuable constituent of cloves is the volatile oil which is present to the amount of from 10 to 20 per cent. The clove stems contain about 5 per cent. of the volatile oil. Oil of cloves is prepared either from the flower buds or the stems.

During the year 1894, 2,655,099 pounds of whole cloves, having an average value of 5.9 cents per pound, were imported into the United States, and during the following year 2,464,274 pounds having an average value of 6.6 cents. A small amount of ground cloves was also brought into the country during these years.

In June, 1897, Amboyna cloves were quoted at wholesale at 10 cents per pound, Zanzibar cloves at 4⅞ cents, and clove stems at 2¾ cents.

Adulteration of Cloves.—Both whole and ground cloves are frequently adulterated with clove stems. A small amount of stems is usually present as an accidental impurity in genuine cloves, but when the amount is considerable, it is an indication that they were added for fraudulent purposes. German authorities state that pure cloves should never contain more than 5 per cent. of stems.

Cloves rendered worthless as spice by extracting the volatile oil of cloves, have been manipulated so as to restore in a measure their original appearance, and employed as an adulterant of unground cloves. We are unable to say whether these exhausted whole cloves are to-day on the market, but manufacturers of oil of cloves are said to dry and prepare their extracted material for mixing with ground cloves and also with ground allspice.

Among the other adulterants commonly used may be mentioned roasted and ground shells of cocoanuts, English walnuts and almonds, red sandal wood, roasted cereal preparations and allspice.

Standard of Cloves.—Pure cloves should contain not less than 10 per cent. of volatile oil, and not less than 4 per cent. of non-volatile ether extract, both determined as stated below in "Methods of Examination," and not more than 8 per cent. of ash.

EXAMINATION OF SAMPLES FROM THE CONNECTICUT MARKET.

Agents of the Station bought 34 samples of ground cloves, all of which with one exception were in bulk (unlabeled packages). These, together with three samples ground at the Station, have been examined chemically and microscopically.

Methods of Examination.—Clove stems and other foreign matters of vegetable origin were detected by the microscope. Chemical analyses were made to corroborate the microscopic evidence and also to ascertain whether exhausted cloves or any other material not revealed by the microscope was present.

Non-volatile ether extract and volatile oil were determined by practically the same method as that described by Richardson.*

Two grams of the material were weighed into a paper cartridge prepared by folding a filter of 11 cm. diameter over a flat-bottomed cylindrical vial 3 cm. in diameter. Both filter and material were dried by standing 16 hours in a desiccator over oil of vitriol, after which the ether-soluble matters were completely exhausted with absolute ether in a Johnson† extractor.

The ethereal solution was transferred to a tared capsule and the ether allowed to evaporate at the room temperature. After standing 18 hours over sulphuric acid, the total ether extract was weighed. This extract was then heated first at 100° for 6 hours and then at 110°, until the weight became constant, the loss being the volatile oil, the residue the fat and resin.

Pure Ground Cloves.—In Table VIII are the results obtained with samples of known purity. From these figures it appears that 10 per cent of volatile oil which German and Austrian analysts consider as the minimum for pure cloves, is none too high and it has been adopted as a provisional standard, at this Station.

In 17 of the 34 ground samples bought in the open market no adulterants were found.

The names and addresses of the dealers from whom these 17 samples were purchased, the price paid per ¼ pound, together with the analytical results, are given in Table IX. The volatile oil in these samples ranged from 10.01 to 16.70 per cent., the fat and resin from 4.90 to 6.20 per cent. and the ash from 6.50 to 8.50. Samples Nos. 7496 and 7328 are included, because they contain a trifle more than 10.00 per cent. of volatile oil. They have, however, a high percentage of ash, which, together with the low percentage of volatile oil indicates that the samples are of poor quality, if not adulterated with clove stems or exhausted cloves.

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* United States Department of Agriculture, Division of Chemistry, Bulletin No. 13, Part II, 1887, p. 165.

† American Journal of Science, March, 1877, p. 196.

Adulterated Ground Cloves.—The particulars with regard to the adulterated samples are given in Table X. All but five of these 14 samples were condemned by both the chemical and microscopical examinations. Of these five samples, four, Nos. 7340, 7476, 7455 and 7393 contained less than 10.00 per cent. of volatile oil and more than 8 per cent. of ash, and were not, therefore, up to the standard of pure cloves. They contained some clove stems, but whether in addition exhausted cloves were present, could not be determined. Only one sample, No. 7444, which under the microscope was found to be adulterated, contained over 10 per cent. of volatile oil.

Although the determination of non-volatile ether extract is not usually of much value, in cases where less than 4.00 per cent is present it may furnish good evidence of adulteration.

Such samples as Nos. 7344, 7412 and 7423, could not have contained more than 25 per cent. of real cloves and probably much less.

No. 7574, the only sample sold in a box with the grinder's name thereon, proved to be badly adulterated. As a rule the name of the grinder on the package is an indication of purity and it is the goods sold in bulk which are more commonly adulterated.

In addition to the adulterants above named, cocoanut shells, wheat, charcoal, wood and allspice were found in some of the samples examined.

TABLE VIII.—CLOVES OF KNOWN PURITY.

Station No.		Volatile Oil.	Non-volatile ether extract.*	Ash.
11053	Penang Cloves, ground at the Station	15.83	5.16	5.70
11051	Amboyna Cloves, ground at the Station	18.32	4.98	6.52
11052	Zanzibar Cloves, ground at the Station	16.10	5.32	6.40

TABLE IX.—GROUND CLOVES, NOT FOUND ADULTERATED, SOLD IN BULK.

Station No.		Dealer.	Price paid per ¼ pound, cents.	Volatile Oil.	Non-volatile ether extract.*	Ash.
7319	*Hartford.*	Woodward & Co, 174 Asylum St.	10	12.20	5.58	7.57
7484		Allen Bros., 132 Main St.	12	16.70	5.40	6.58
7500		E. M. Palmer, 124 Albany Ave.	10	11.50	6.15	7.57
7493		Empire Cash Grocery, 94 Albany Ave.	8	13.05	5.91	7.00
7335		H. J. Case, 433 Main St.	10	14.65	5.05	6.92
7496		Cady and Lombard, 69 Albany Ave.	10	10.04	4.90	7.95
7328		Boston Branch Grocery, 271 Main St.	9	10.01	4.96	8.50
7480		A. H. Tillinghast, 91 Main St.	10	12.50	5.00	7.38
7406	*New Haven.*	Savings Bank Grocery, 377 Congress Ave.	8	14.68	5.98	6.75
7464		A. B. Stevens, 61 Broadway	10	12.00	5.38	7.50
7445		H. M. Tower, 379 Congress Ave.	7	14.24	6.20	6.93
7361	*Willimantic.*	A. A. Trudeau, 931 Main St.	10	11.63	5.35	7.55
7388		H. C. Hall, 17 Union St.	12	13.80	5.16	7.17
7371		Burt Thompson, 798 Main St.	11	15.15	6.13	6.50
7376		Purinton & Reade, 707 Main St.	20	15.55	5.38	6.75
7357		Frank Larrabee, 16 Church St.	12	13.85	5.68	7.02
7379		C. R. Hubbard, 22 North St.	12	12.50	5.15	7.35

*Fat and resin.

TABLE X.—ADULTERATED GROUND CLOVES. SOLD IN BULK.

Station No.		Dealer.	Adulterants.	Price per ¼ pound. cents.	Volatile Oil.	Non-volatile ether extract.†	Ash.
7344	*Hartford.*	John Sloan & Co., 319 Asylum St.	Cocoanut shells, Allspice	10	**2.43**§	5.29	7.45
7340		Hills & Co., 368 Asylum St.		10	**5.45**	5.65	**8.60**
7476		Lane & Co., cor. Church and Trumbull Sts.		10	**5.90**	6.30	**8.50**
7474		C. H. Russell, 383 Main St.	Starchy matter	5	**8.50**	4.50	6.65
7444	*New Haven.*	Conrad Weiss, cor. Chapel and Franklin Sts.	Cocoanut shells, Wheat	10	15.00	6.47	5.45
7437		Graff & McKay, 51 Green St.	Wheat	10	**9.00**	5.56	6.10
7412		Kohn Bros., 55 George St.	Cocoanut shells, Starchy matter	10	**2.75**	5.25	5.40
7470		John T. Pohlman, 140 Dixwell Ave.	Cocoanut shells, Wheat	10	**7.18**	**3.90**	**13.25**
7419		——— 794 Grand Ave.	Cocoanut shells, Wheat	10	**3.85**	4 45	6.20
7423		S. Lapido, 760 Grand Ave.	Cocoanut shells, Allspice, Wheat	10	**2.93**	**3.25**	7.70
7455		D. M. Welch, 28 Congress Ave.		8	**5.58**	4.48	**8.62**
7434		L. Schmidt, 121 Hamilton St.	Wheat	10	**7.45**	5.75	6.07
7428		Fred. A. Basserman, 627 Grand Ave.	Wheat	10	**7.28**	5.80	7.90
7397	*Norwalk.*	Brown & Wilcox, 70 Washington St.	Wheat	10	**9.75**	4.50	7.00
7393		W. & E. Osterbanks, 53 Main St.		10	**8.48**	4.98	**8.15**
7574*	*Willimantic.*	S. E. Amidon	Cocoanut shells. Wheat	10	**7.63**	4.23	5.50
7365		S. E. Amidon	Wheat, charred matter, Red wood	10	**4.23**	**3.38**	5.35

* Sold in tin box with label "E. S. Kibbe & Co., 133 to 143 State St., Hartford. Pure Cloves."

† Fat and resin.

§ Figures in heavy type indicate percentages not found in unadulterated cloves.

ALLSPICE.

By A. L. Winton.

Nature.—Allspice or Pimento is the dried berry of a small tree (*Pimento officinalis* Lindl.), a native of the West Indies, and now extensively cultivated in Jamaica. The spice contains about four per cent. of volatile oil, which gives it a flavor resembling that of cloves, although much milder.

During 1894 the imports of allspice into the United States amounted to 4,596,469 pounds and during the following year to 4,284,741 pounds. Jamaica allspice was quoted June, 1897, at 4¾ cents per pound.

Adulteration of Allspice.—Ground clove stems are very commonly added to ground allspice, as they cost only about half as much and have nearly the same appearance and flavor. Ground cocoanut shells, another common adulterant, resembles allspice very closely in appearance. Shells of other nuts and various cereal products, after being roasted to give them the required color, are also employed as makeweights. Small amounts of cloves are sometimes added to give flavor.

Examination of Samples from the Connecticut Market.

One sample of whole allspice, known to be pure, and 23 of ground allspice, sold in bulk in Connecticut, have been examined. The methods employed were the same as those described under cloves, p. 25.

Pure Allspice.—The sample of pure whole allspice (Jamaica), No. 11031, contained 3.52 per cent. of volatile oil, 6.48 per cent. of non-volatile ether extract, and 4.57 per cent. of ash.

In 12 of the 23 samples purchased no adulterants were found. These are described in Table XI.

The volatile oil ranged from 2.05 to 2.84, the non-volatile ether extract from 3.98 to 5.62 and the ash from 4.62 to 5.50. None of these samples contained as much volatile oil or non-volatile ether extract or as little ash as the pure whole allspice.

Adulterated Allspice.—Eleven samples, belonging to this class, are described in Table XII. Five of them contained clove stems, two, cocoanut shells with a wheat product and cloves, and four contained cocoanut shell powder, probably without other foreign material.

When the samples contained cloves or clove stems, the microscope was depended on to detect the adulteration, since the determinations of volatile oil showed no deficiency of this ingredient. Only where powder of cocoanut shells was the only foreign material, did the per cent. of volatile oil by itself furnish any evidence of adulteration.

TABLE XI.—ALLSPICE, NOT FOUND ADULTERATED, SOLD IN BULK.

Station No.	Dealer.	Price per ¼ pound. Cents.	Volatile Oil.	Non-Volatile Ether Extract.	Ash.
7323	*Hartford.*—Woodward & Co., 174 Asylum St.	10	2.30	4.76	5.50
7334	H. J. Case, 433 Main St.	10	2.84	5.30	5.34
7346	John Sloan & Co., 319 Asylum St.	11	2.45	3.98	5.15
7338	Hills & Co., 368 Asylum St.	10	2.38	4.80	4.62
7429	*New Haven.*—Fred. A. Bassermann, 627 Grand Ave.	9	2.63	4.85	4.90
7449	H. M. Tower, 379 Congress Ave.	7	2.67	5.62	5.05
7398	*South Norwalk.*— Brown & Wilcox, 70 Washington St.	10	2.48	4.45	5.00
7356	*Willimantic.*—Frank Larrabee, 16 Church St.	10	2.70	5.51	5.12
7363	A. A. Trudeau, 931 Main St.	10	2.05	4.56	5.37
7380	C. R. Hubbard, 22 North St.	10	2.75	5.21	4.70
7367	S. E. Amidon, 877 Main St.	10	2.65	5.05	4.83
7373	Burt Thompson, 798 Main St.	10	2.33	4.93	4.93

TABLE XII.—ADULTERATED ALLSPICE SOLD IN BULK.

Station No.	Dealer.	Price per ¼ pound. Cents.	Adulterants.	Volatile Oil.	Non-Volatile Ether Extract.	Ash.
7424	*New Haven.*—S. Lapido, 760 Grand Ave.	10	Cocoanut shells.	**1.40***	**2.60**	3.55
7431	L. Schmidt, 121 Hamilton St.	10	Cocoanut shells, Wheat, Cloves.	3.65	4.00	**7.10**
7415	Grocery, 794 Grand Ave.	8	Cocoanut shells.	**1.82**	5.38	**6.50**
7468	John T. Pohlman, 140 Dixwell Ave.	10	Cocoanut shells, Wheat, Cloves.	3.50	4.22	**6.43**
7414	Kohn Bros., 55 George St.	12	Cocoanut shells.	**1.87**	**2.90**	5.35
7463	A. B. Stevens, 61 Broadway.	10	Clove stems.	2.48	4.73	**6.32**
7441	Conrad Weiss, 485 Chapel St.	9	Clove stems.	2.45	4.53	**6.40**
7439	Graff & McKay, 51 Greene St.	10	Clove stems.	3.22	5.21	**7.10**
7456	D. M. Welch, 28 Congress Ave.	8	Clove stems.	3.05	4.18	**7.57**
7389	*Willimantic.* — H. C. Hall, 17 Union St.	10	Clove stems.	3.85	4.55	**8.25**
7377	Purinton & Reade, 707 Main St.	10	Cocoanut shells.	2.13	4.50	**8.28**

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* Figures in heavy type indicate percentages which we have not found in unadulterated allspice.

CINNAMON.

By A. L. Winton.

Nature.—True cinnamon is the inner bark of the young branches of a small tree (*Cinnamomum Ceylanicum* Breyne), cultivated chiefly in Ceylon. It is usually shipped in the form of sticks, consisting of several pieces of the thin bark curled one inside of another.

Cassia is a thicker bark derived from several other species of the genus *Cinnamomum* and constitutes the spice which is known in the household, both ground and unground, under the name of "cinnamon."

This usage of the word "cinnamon" as applied to cassia, has become firmly established in retail trade, and true cinnamon is practically out of the market as a spice. Not only are the cheaper kinds of cassia known under that name, but also Saigon cassia, which costs more and has greater strength than true cinnamon.

During 1894, 283,653 pounds of unground cinnamon or a spice under that name, were imported and during the following year 227,513 pounds, while during the same years the imports of cassia were respectively 2,680,242 and 4,291,688 pounds.

Ceylon cinnamon costs at wholesale from 7 to 25 cents per pound. Saigon cassia, which is considered the best, was quoted July, 1897, at 36½ cents per pound, rolls, and 29 cents broken; Batavia at 17 cents, rolls, and 14 cents broken; and Canton at 8 cents, rolls, and 5 cents broken. The difference in the quality of these several grades is as marked as the difference in the price.

Standard of pure Cinnamon.—The Austrian, Bavarian and Swiss food analysts consider as adulterated all cinnamon or cassia containing over 5 per cent. of ash or over one per cent. of sand.

Adulteration of Cinnamon.—Cereal products, sawdust, various kinds of bark, nut shells and exhausted cassia are among the adulterants used in ground cinnamon.

Examination of Samples from the Connecticut Market.

Method of Examination.—By microscopic examination adulterants of vegetable origin were detected, with the possible exception of exhausted cinnamon.

Formerly oil of cinnamon was prepared by distillation and the bark which had been exhausted by this process could be recognized by the absence of perfect starch granules and the deficiency of alcoholic extract. But other processes are now used to extract the essential oil and examination for exhausted cassia has been deferred by us until the methods of detecting this adulterant can be more thoroughly studied.

Determinations of ash and sand were made by the usual methods.

Thirty-four samples of cinnamon sold in bulk have been collected and examined.

Twenty-eight samples were found to consist of cassia bark. Whether or not they contain exhausted cassia, has not been ascertained. The percentages of ash in these samples ranged from 3.08 to 5.97.

Adulterated Cinnamon.—Eight samples were variously adulterated with buckwheat middlings, wheat bran and other wheat products, red sandal wood and other wood, and sand. (See Table XIII.)

No. 7477 consisted chiefly of starchy matter from wheat, which was probably added in the form of cracker waste or ship bread.

One sample, No. 7411, contained buckwheat middlings in considerable quantity. No. 7396 was a worthless mixture of red sandal wood and wheat bran with a little cassia. The high percentage of ash and sand in Nos. 7435, 7420 and 7440 condemns them, although the exact character of the other adulteration was not determined.

TABLE XIII.—ADULTERATED CINNAMON.

Station No.		Dealer.	Price per ¼ pound. Cents.	Adulterants.	Ash.
7477	*Hartford.*	Copeland Grocery, 56 Pleasant St.	7	Wheat (probably biscuit).	5.18
7435	*New Haven.*	Graff & McKay, 51 Greene St.	10	Sand	11.15*
7411		Kohn Bros., 55 George street	12	Buckwheat	6.34
7420		S. Lapido, 760 Grand avenue	6	Sand	10.22†
7469		John T. Pohlman, 140 Dixwell avenue	8	Wheat	11.79‡
7440		Conrad Weiss, 485 Chapel St.	10	Sand	12.37§
7416		Grocery, 794 Grand avenue	8	Wood, Wheat	3.40
7396	*So. Norwalk.*	Brown & Wilcox, 70 Washington St.	10	Red Sandal wood, Wheat Bran	3.76

* 6.94 per cent. sand. † 6.23 per cent. sand. ‡ 2.05 per cent. sand.
§ 9.50 per cent. sand.

TOMATO CATSUP.

By A. L. Winton.

Tomato catsup or ketchup as prepared in the household consists of ripe tomatoes cooked with spices and vinegar and strained to remove seeds and skins. Fermentation and the growth of molds is prevented chiefly by virtue of the added spices and vinegar. Carefully prepared catsup keeps for months while bottled and for several weeks after opening.

Some of the tomato catsup sold in the stores is doubtless prepared from wholesome materials, but it is reputed to be made sometimes from refuse of the tomato canneries and it frequently contains artificial coloring matter and chemical preservatives.

Uncolored catsup never has such a bright red color as many of the sorts on the market, which the manufacturers claim are made by a peculiar process whereby the natural color of the tomato is retained. The colors which have been detected in catsup by Prof. Weber, of the Ohio Dairy and Food Commission, are cochineal and carmine, together with eosine, acid magenta, and various other coal tar dyes.

We have confined our attention at this Station to the detection of salicylic acid and benzoic acids, the two preservatives most commonly used in catsup.

EXAMINATION OF SAMPLES FROM THE CONNECTICUT MARKET.

Method of Testing for Salicylic Acid and Benzoic Acid.—Twenty-five to fifty cc. of the catsup were thoroughly shaken in a tube of suitable size with an equal bulk of ether and whirled for a few minutes in a centrifugal machine* at the rate of 800 revolutions per minute. By this means a clear, ethereal extract was readily obtained such as would not usually separate by gravity alone except on long standing. The ethereal solution was carefully decanted into a flat porcelain dish and the ether evaporated at a gentle heat. The residue was taken up with absolute alcohol and the solution allowed to evaporate to dryness at the room temperature. The presence of salicylic acid was indicated by the appearance of characteristic fibrous crystals. and that of benzoic acid by shining crystalline scales. The residue was further tested as follows:

Salicylic Acid —A portion of the residue was dissolved in absolute alcohol and tested with ferric chloride solution.

To further confirm the presence of salicylic acid, another portion of the crystalline residue was heated with methyl alcohol and a few drops of sulphuric acid. The methyl salicylate, formed by this treatment, was readily detected by its characteristic odor.

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* A centrifugal machine made for the Babcock milk test was used.

Benzoic Acid.—A portion of the residue was cautiously heated and if fumes of this acid were given off they were collected on a cool surface. The crystalline sublimate was demonstrated to be benzoic acid by the following tests:

(1). The melting point was determined.

(2). Some of the crystals were dissolved in ammonia and the solution evaporated to dryness to remove excess of the alkali. The residue was dissolved in water and divided into two portions. To one portion neutral solution of ferric chloride was added, which gave the flesh-colored precipitate of ferric benzoate. Addition of strong hydrochloric acid decomposed this precipitate with separation of benzoic acid.

(3). The other portion of the aqueous solution of ammonium benzoate (prepared according to 2), was mixed with an equal bulk of absolute alcohol and a few drops of copper sulphate were added dropwise. A light blue precipitate of cupric benzoate was thus obtained.*

Forty-one brands of tomato catsup found on sale in Connecticut, were tested for benzoic and salicylic acids as above described.

From the results of the examination the different brands are grouped in three tables on following pages:

Table XIV includes samples in which neither salicylic nor benzoic acids was detected; Table XV, samples containing salicylic acid; Table XVI, samples containing benzoic acid.

Only 6 brands of tomato catsup found on sale were free from the acid preservatives above named. Of the remaining 35 brands collected, 27 contained salicylic acid and 8 benzoic acid.

CHILI SAUCE.

A sample (No. 11,138) labeled "Gold Leaf Chili Sauce, Capitol City Pickle House, Hartford, Conn., J. S. Birden & Co.," was found to contain salicylic acid.

CONFECTIONERY.

Shortly before Christmas, 1896, 30 samples, mostly of the cheaper sorts of confectionery, were bought at 11 different stores and candy factories in New Haven and examined by the Station Chemists.

All of the samples were free from poisonous mineral colors and terra alba.† In one case there were indications of the presence of a fluorescent aniline dye.

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* See Horn, Zeitsch. Analyt. Chem., 30, 732.

† Terra alba, literally signifying "white earth," is a trade name for some cheap, tasteless and flavorless white substance, in powder, which can be used as a make-weight adulterant. Pipe clay and gypsum are commonly sold under this name.

TABLE XIV.—CATSUP CONTAINING NEITHER SALICYLIC NOR BENZOIC ACID.

Station No.	Brand.	Dealer.	Price per bottle. Cents.	Fluid ounces* in bottle.
11100	Extra Spiced Home Made Catsup, O. K. Alart & McGuire	The Hub Grocery, New Britain	10	24
11101	Flaggus Bros. Tomato Catsup, Wheeling, W. Va.	Rallion, 45 Broadway, Norwich	25	14
11102	Gulden's Strictly Pure Catsup	Union Trading Co., 77 Arch St., New Britain	10	10
7318	Shrewsbury Tomato Ketchup, E. C. Hazard & Co., Shrewsbury, N. J.	Woodward & Co., 174 Asylum St., Hartford	15	7
11103	Manufactured by W. W. Turner, Quaker Hill, Conn.	Corkey & Gannon, 29 Main St., New London	15	15
11104	Superior Tomato Catsup for Family Use	Boston Branch, 77 Water St., Norwich	15	19

* One pint equals 16 fluid ounces.

TABLE XV.—TOMATO CATSUP CONTAINING SALICYLIC ACID.

Station No.	Brand.	Dealer.	Price per bottle. Cents.	Fluid ounces in bottle.
11105	Bergen's Excelsior Tomato Catsup, 472 Greenwich St., New York	Maylinger & Hugo, 120 Crown St., New Haven	15	15
11106	J. S. Birden & Co., Hartford, Gold Leaf Tomato Catsup	Daniel Flynn, 138 Main St., Hartford	10	9
11107	Capitol City Pickle Factory, Hartford, Conn., Birden's Favorite Gilt Edge Tomato Catsup	F. H. Kearney, 74 Congress Ave., New Haven	25	15
11108	A. C. Blenner & Co.s Pure Brand Tomato Catsup. New Haven	W. F. Ackley, Main St., Middletown.	9	9
7305	Bryan, Miner & Read. New Haven, Connecticut Brand, Catsup	192 Front St., Hartford	10	12
11109	Bryan, Miner & Read None Such Tomato Ketchup	C. F. Fox, 26 East Main St., Meriden	10	9
11110	Classen's White Label Tomato Ketchup. Sole Agts., W. R. Sayer & Co., New York	Amos T. Otis, 255 Main St., Norwich	25	16
11111	Curtice Bros. Co., Rochester, N. Y., Blue Label Tomato Ketchup	Edw. E. Hall & Son, 770 Chapel St., New Haven	25	16
11112	The John T. Doyle Co., New Haven, Conn., Royal Tomato Catsup	Wesley Northrop, New Milford	20	15
11113	Eagle Extract Co., E. C. Ward, Prop., 15 Farnsworth St., Boston, Bull Brand Tomato Ketchup	Cole Bros., 58 Church St., Willimantic	5	9
11114	Eureka Tomato Catsup Co., St. Louis. Eureka Tomato Catsup	R. T. Whiting, 345 Main St.. Bridgeport	6	9
11115	Franklin Packing Co.. New York, Franklin Tomato Catsup	M. W. Dart Bank St, New London	25	15
11116	D. H. Geer & Son Boston, Mass., Perfection Tomato Sauce	J. E. St. John, 265 Bank St., New London	10	12
11117	H. J Heinz Co., Pittsburg, Octagon Style Heinz's Keystone Ketchup	O. Sheldon, 72 W. Main St., New Britain	25	9
7383	E. S. Kibbe Co., Hartford, Superior Tomato Catsup	C. R. Hubbard, 22 North St, Willimantic	10	11
11118	Francis H. Leggett & Co. New York, Riverside Tomato Catsup	Perkins & Blish, 66 Church St., Willimantic	25	17
11119	The Longfield-Bergen Co., 472 Greenwich St., New York, Pride of Long Island Tomato Ketchup	Henry Woodhull, 205 Main St., Bridgeport	10	9
11120	McMechen's Old Virginia Ketchup, Wheeling W. Va.	W. H. Cole, 386 State St., Bridgeport	15	9
11121	National Pure Food Co, Boston & Cincinnati, Tomato Catsup	L. Brown, 4 W. Main St., Meriden	20	15
11122	Isaac Schull, Newark, N. J., Gilt Edge Tomato Catsup	500 Main St, New Britain	10	9
11123	The T. A. Snider Preserve Co., Cincinnati, Snider's Home Made Catsup	W. C. Wade, 199 State St., Hartford	25	16
11124	Standard Packing Co, Indianapolis, Ind., Home Made Tomato Catsup	Durfey's Tea, Coffee & Spice House, 375 Main St., Hartford	15	14
11125	Stoddard, Kimberly & Co., New Haven, High Grade Tomato Catsup	Wesley Northrop, New Milford.	10	9
11126	J. D. Stone & Co., Bay Ridge Tomato Catsup	M. Hackett, 80 E. Main St., Meriden	10	15
11127	J. E Thompson, New York, New England Catsup	H. I. Palmer, 231 Main St., Norwich	10	9
11128	Van Camp Packing Co., Indianapolis, Ind., Van Camp's Pure Catsup	Boston Branch Grocery, 238 Main St., New Britain.	13	9
11129	West Virginia Preserving Co., Wheeling, W. Va., Nail City Catsup	Edw. E. Hall & Son, 770 Chapel St., New Haven	13	9

TABLE XVI.—TOMATO CATSUP CONTAINING BENZOIC ACID.

Station No.	Brand.	Dealer.	Price per bottle. Cents.	Fluid ounces in bottle.
11130	Alart & McGuire, 68 Madison St., New York, Oyster Bay Tomato Ketchup	Grocery cor. Main St. and R. R. track, New Britain	5	9
11131	The Celebrated Bar Harbor Tomato Ketchup	Thomas & Gumble, 437 Bank St, New London	13	17
11132	A. Boeckmann, 186 Conselyea St., Brooklyn, Tomato Ketchup	O. T. Thorsen, 286 Park Ave., Bridgeport	5	9
11133	G. S Brown & Co, Boston, Mass., Superior Tomato Catsup	Foley's Public Market, 487 Main St., Hartford	10	24
11134	E. W. Byrne, New Britain, Superior Tomato Catsup	Thomas McCabe, 591 Main St., New Britain	15	24
7153	Jos. Campbell Preserving Co., Camden, N. J., Beef Steak Tomato Ketchup	W N. Ladd, 94 S. Main St., Waterbury	20	15
11136	The Eureka Chemical Co., New Haven, Welcome Fancy Tomato Ketchup	Wesley Northrop, New Milford	20	15
11137	The J. V. Sharp Canning Co., Williamstown, N. J., Violet Catsup	James Gleave, 905 Main St., Willimantic	8	8

HONEY.

A single sample labeled "Busy Bee Brand, Pure Strained Honey," bought of Boston Branch Grocery, 238 Main st., New Britain, and examined by Mr. Ogden, is free from mixture with glucose syrup.

Direct polarization	—16.0 at 23° C.
After inversion	—19.8 " 24.5° C.

MAPLE SYRUP.

A. "Maple Sap Syrup," put up and guaranteed by Welch Bros. Maple Co., Burlington, Vt.

B. "Pure Maple Syrup," put up by the Vermont Farmers' Maple Sugar Association, 43 to 49 Lyman st., Springfield, Mass.

C. "Vermont Maple Syrup," packed by Hildreth Bros. & Segelken, 28–30 West Broadway, N. Y.

The composition of these samples, determined by Mr. Ogden, is as follows:—

	A.	B.	C.
Cane Sugar (Sucrose)	61.90	65.60	67.00
Invert Sugar (Levulose and glucose)	.17	.13	.41
Water	34.80	33.10	30.70
Other matters (by difference)	3.13	1.17	1.89
	100.00	100.00	100.00

Neither of these samples is adulterated with glucose syrup.

The examination does not show whether the samples are genuine maple syrup or have been "adulterated" with sugar, made from sugar cane or beet root.

SAUSAGES.

Forty-two samples of sausages collected during the months of October, November and December, 1896, have been examined by Messrs. Ogden and Mitchell solely with reference to certain antiseptics.

Tests were made for borax, salicylic and benzoic acids.

In twenty-seven of the forty-two samples borax was found. Neither of the other antiseptics named was detected in any of the samples examined.

The names of brands of sausages examined, with names of the dealers from whom they were bought, are given in Tables XVII and XVIII, p. 41.

It will be noticed that in the samples of Sperry & Barnes sausages bought in New Haven, Bridgeport, Middletown and Meriden, borax was not detected, while the samples of the same brand bought in Ansonia, Waterbury, South Norwalk and New London contained borax.

In several cases the quantity of borax actually present was determined by Mr. Mitchell following the method of Gooch.

Separation and Determination of Boric Oxide.

450 to 500 grams of the material to be examined, intimately mixed with 10 grams of calcium hydrate, were dried and ignited in a platinum dish. The residue was dissolved in cold nitric acid and chlorine was precipitated with silver nitrate solution.

The filtrate from this precipitation was made up to 500^{cc} and boric oxide determined in 25^{cc}.

The solution was introduced into a flask of 150^{cc} capacity, which was provided with a thistle tube that could be closed by a glass stopcock. This flask was connected with a condenser, through the wide tube of which the distillate was delivered below the surface of the liquid in the receiver.

A weighed platinum dish of 150^{cc} capacity was used as a receiver, and contained a weighed quantity of ignited lime, suspended in water.

For the determination, 10^{cc} of methyl alcohol were run into the flask with the borate solution and heated at about 140° C. on a paraffine bath.

During distillation the liquid in the receiver was constantly stirred to keep it alkaline. This precaution is absolutely necessary, for otherwise the calcium hydrate sinks to the bottom and boric acid or boric ether escapes from the surface. Subsequently 60^{cc} of methyl alcohol were run into the flask, in five cc. portions, and distilled off.

When the distillation was finished the contents of the platinum dish were evaporated to dryness and ignited over the blast lamp till the weight was constant.

The gain of weight, due to boric oxide, multiplied by 2.728, gives the equivalent of borax.

To test this method, two grams of pure boric acid were mixed with a pint of "oysters" (the usual mixture of oysters and water), and the boric oxide was then determined in the way just described.

Following are the results:

Boric oxide (B_2O_3) in the aliquot. grams.	Boric oxide found. grams.	Difference. grams.
.0564	.0531	—.0033
.0564	.0527	—.0037
.0564	.0570	+.0006
.0564	.0561	—.0003

The quantities of borax found by Mr. Mitchell in five samples of sausages bought in New Haven were as follows:—

	Bologna. Maylinger & Hugo.	Deer-foot E E. Hall & Son.	Merwin's.	Public Market.	Public Market.
Grains of borax in 1 pound of sausage	8.4	26.1	20.7	35.5	50.4
Parts by weight of borax in 1000 parts of sausage	1.2	2.7	3.0	5.1	7.2
Parts by weight of sausage to 1 part of borax	915	294	371	217	152

HEAD CHEESE.

No borax was found in a sample bought of D. M. Welch & Co., New Haven. In a sample bought at the New Haven Public Market, New Haven, Mr. Mitchell found by the method described on page 39, 12.34 grains of borax to the pound of head cheese, which is equivalent to 1.76 parts of borax in 1000 of head cheese.

SALT CODFISH.

All of the samples of salt codfish collected, eleven in number, were examined by Messrs. Ogden and Mitchell and found to contain borax.

The brands tested were

"Beardsley's Shredded Codfish," Beardsley's Sons, 179 West St., N. Y.

"Crescent Bricks," J. D. Dewell & Co., New Haven.

"Little Pearl Brand."

"H. E. Taylor's Brand."

"Mother Ann George's Codfish," Slade, Gorton & Co., Gloucester, Mass.

Shute & Merchant's "Gold Wedge, Fibered," Gloucester, Mass. (2 samples).

"Delicatessen Brand Picked Codfish," packed by Gloucester Mackerel Co., Gloucester, Mass. Three samples of picked codfish without special brands.

OYSTERS.

Seventy-five samples of opened oysters have been examined which were purchased in the following places: Ansonia, Derby, Hartford, Meriden, Middletown, New Britain, New Haven, New London, Norwich, Putnam, So. Norwalk, Waterbury, Willimantic and Winsted.

These were tested for borax by Messrs. Ogden and Mitchell.

TABLE XVII.—SAUSAGES FREE FROM BORAX, SALICYLIC AND BENZOIC ACIDS.

Manufacturer.	Dealer.
Made by Booth Meat Co, New Haven	Booth Meat Co, 370 State St, New Haven.
Made by H. Howey, Willimantic	H. Howey, Willimantic.
Vienna Sausage, National Pure Food Co, N. Y	Harry Leigh, 384 State St., New Haven.
Plumb & Winton, Bridgeport	Plumb & Winton, Bridgeport.
E. Schonberger, New Haven	E. Schonberger, 94 George St, New Haven.
Sperry & Barnes, New Haven	B. Liebscher, 652 Main St., Bridgeport.
" " " "	J. B. Richards, 159 State St., New Haven.
" " " "	R A. Chapman, 374 Main St., Middletown.
" " " "	Petton & Greene, 65 West Main St., Meriden.
Bologna Sausage	Sweet's Market, 94 Franklin St., Norwich.
" "	Cheever's Market, 32 N. Main St., Waterbury.
Blood Sausage	Maylinger & Hugo, 120 Crown St., New Haven.
Liver Sausage	Geo. F. Barnstorff 45 Main St., New London.
" "	C. W. Hartung, 806 Bank St., Waterbury.
" "	Whitlock's Market, 12 Main St., Norwalk.

TABLE XVIII.—SAUSAGES CONTAINING BORAX.

Name or Brand, Manufacturer.	Dealer.
Bologna Sausage	Klinck's Market, 137 Bank St., New London.
" "	Maylinger & Hugo, 120 Crown St., New Haven.
" "	" " " " "
" "	N. Y. Market, Washington St., So. Norwalk.
" "	B. Moffitt, 373 Main St, New Britain.
Frankfort Sausage	Maylinger & Hugo, 120 Crown St., New Haven.
Sausage, Brightwood make	A. R. Hull, 552 Asylum St, Hartford.
Deerfoot Farm Sausages	E. E Hall & Son, New Haven.
" " "	Gilbert & Thompson, Chapel St., New Haven.
Made by John Flinn, Hartford	John Flinn, 133 Main St., Hartford.
S. E. Merwin & Son, New Haven	S. E. Merwin & Son, 426 State St., New Haven.
" " " "	" " " " " "
New York Sausage	C. W. Hartung, 806 Bank St., Waterbury.
Sausage	H. C. Booth, Manager Public Market, 392 State St., New Haven.
"	
Boston Sausage	
Sperry & Barnes' Sausage	J. A Bristol & Son, 238 Main St., Ansonia.
" " "	C. L. Rogers, 96 East Main St., Waterbury.
" " "	NewYork Market, Washington St., So. Norwalk.
" " "	Whitlock's Market, 12 Main St., Norwalk.
" " "	Harrington Bros., 69 Bank St., New London.
Springfield Sausage	B Moffitt, 373 Main St., New Britain.
" "	Sweet's Market, 94 Franklin St., Norwich.
" "	City Market, 311 Main St., New Britain.
J. P. Squires	Randall & Co., Putnam.
" "	Klinck's Market, 137 Bank St., New London.
" "	C. E. Williams, 20 Main St., New London.

Sixty-two samples of oysters free from borax were bought at the following places.

Derby.—Fish and Oyster House, cor. Main and Olivia Sts.

Hartford.—John A. Pilgard, 138 Front St.; W. C. Wade, 199 State St.; E. W. Bull, 325 Asylum St.; Murray's, 253 Asylum St.; Newton & Burnet, 341 Asylum St.; Bartlett & Case, 554 Asylum St.; John Flinn, 133 Main St.; T. A. Honiss, 30 State St.; L. G. Abbe, 183 State St.; S. R. Hyde, 253 Asylum St.

Meriden.—City Fish Market, Crown St.; L. C. Brown, 4 W. Main St.; J. H. Preston, 25 E. Main St.

Middletown.—City Fish Market, 114 Centre St.; 170 Main St.; F. W. Leonard, 104 Main St.

New Britain.—Wright's Oyster House, 297 Main St.; Carroll & Hansel, 60 W. Main St.; F. M. Walker, 127 Main St.

New Haven.—D. Ackley & Son, 24 Congress Ave.; A. Foote & Co., 353 State St.; C. A. Wilcox, 490 State St.; Doolittle Bros., 93 Broadway; Mr. Ferdinand, 434 Congress Ave.; C. L. Barnes, 81 Webster St.; John T. Pohlman, 142 Dixwell Ave.; Doolittle Bros., 93 Broadway; D. Burton Brown, 744 Grand Ave.; Conroy & Foley, 312 Grand Ave.; D. H. Granniss, 262 Quinnipiac St.; C. A. Wilcox, 490 State St.; Chas. Schraeder, 537 State St.; Michael Starrs, 227 Congress Ave.; Silas Stow, 763 State St.; W. H. Wilson, 78 Congress Ave.; H. W. Smith, 59 Church St.; W. H. Maynard, 169 Washington St.; Chas. Harris, 159 Washington St.; A. D. Vinton, 1 E. Grand, Annex; S. C. Burwell, 73 Front St.; S. W. Glenney, 81 Wooster St.

New London.—C. B. Pimer, 446 Bank St.; Hamilton, Powers & Co., 58 Bank St.; Henry Lester, 133 Bank St.

Norwich.—Offenheiser's Fish Market, 73 W. Main St.; J. T. Fitzpatrick, 64 Franklin St.

Putnam.—Willis & Brown; H. C. Penniman; S. E. Morse.

So. Norwalk.—N. Y. Market, Washington St.; Hunt & Zeluff, 36 Washington St.

Waterbury.—N. S. Snow, 134 S. Main St.; M. A. Moore, 804 Bank St.; City Fish Market, 247 S. Main St.

Willimantic.—F. P. Strong, North St.; Cole Bros., Church St.

Winsted.—Johnson's Cash Market, Main St.; Peck Fish Co., Main St.

Thirteen samples were found to contain borax.—Five of the thirteen were Homan's oysters, in pint bottles with printed labels. One of the labels is as follows: "Homan's Pelham Bay Oysters.

All goods bearing our name are guaranteed to be pure and as represented."

The samples of Homan's oysters were bought of C. Thagerson, Ansonia; N. A. Fullerton, New Haven; H. A. Merrill, 266 N. Main St., Waterbury; S. E. Amidon, Willimantic.

Other oysters containing borax were bought of Harding & Holbrook, 567 Main St., Hartford; City Market, 487 Main St., Hartford; W. J. Burns, 544 Asylum St., Hartford; W. J. Dorman, 126 Columbus Ave., New Haven; A. Foote & Co., 353 State St., New Haven; H. C. Penniman, Putnam.

The quantity of borax in some of the samples was determined by Mr. Mitchell as follows:

QUANTITIES OF BORAX FOUND IN OPENED OYSTERS.

	Homan's			
	Genuine Blue Point.	Pelham Bay.	Harding & Holbrook's.	City Market, Hartford.
Grains of borax in one pint	34.0	38.4	5.5	8.6
Parts by weight of borax in 1000 of oysters	4.4	5.7	0.7	1.1
Parts by weight of oysters to one of borax	227	176	1347	875

OLIVE OIL.

BY A. L. WINTON.

Source.—The ripe fruit of the olive tree (*Olea Europœa*) contains from 20 to 30 per cent. of oil, chiefly in the pulp. The olive pit, within the stone, yields relatively a small amount of oil, of inferior quality.

The process of manufacture consists in crushing the olives, best without breaking the stones, and subjecting them to cold pressure. The expressed liquid is allowed to stand and the oil which rises to the surface is removed. After clarification by filtering and racking off from the dregs, the oil is ready for use. Inferior grades are obtained by pressing the pomace a second and a third time, finally with the aid of heat.

In Palestine, Greece, Italy, France, Spain and other of the warmer countries of the old world, the olive tree has been grown for centuries and olive oil forms an important article of food.

The tree was introduced in colonial times into tropical and subtropical America by the Spanish. From Mexico its culture spread into California, where it now grows in great perfection. The pure olive oil in the Connecticut market comes largely from France and Italy, but oil of excellent quality is now produced in California.

Adulteration of Olive Oil.—Owing to the high cost of the finer grades, olive oil has been extensively adulterated with the oils of cottonseed, sesame, peanut, linseed and poppy, as well as with cheap animal oils. Besides being used as adulterants, some of these, notably cottonseed oil, are also sold under their true names as substitutes for olive oil.

EXAMINATION OF SAMPLES OF "OLIVE OIL" FROM THE CONNECTICUT MARKET.

Eighty-one samples for examination have been purchased by agents of the Station in various parts of the State. Of these, sixty were from grocers and twenty-one from druggists. Samples were bought from drug stores because many prefer to buy olive oil for table use in bulk from druggists, rather than the brands in sealed bottles found in grocery stores. In purchasing these samples care was taken to ask for "table olive oil," as that sold for other purposes does not come within the scope of the food law.

Method of examination.—The following tests were employed:

1. Specific gravity at 15° C. determined by the Westphal balance.
2. Iodine absorption number by Hübl's method * following Wesson's plan† for weighing the fat.
3. Bechi test as modified by Dudley.‡
4. Baudouin test for sesame oil § Twenty cc of the oil are shaken violently with 10 cc. of strong hydrochloric acid, in which has been dissolved .1 to .2 gram of sugar. The watery liquid is yellow if the oil be pure, but in the presence of sesame oil it quickly acquires a deep red color. In doubtful cases the test should be made on the fatty acids also, obtained by the usual method.
5. Renard test‖ for arachidic acid as modified by DeNegri and Fabris.¶

Olive Oil not found adulterated.—In 37 of the brands bought of grocers no adulteration was detected. The brands, names and addresses of the dealers, prices paid per bottle, the number of ounces in the bottles and the results of the examinations are given in Table XIX, pages 48 and 49.

Table XX gives descriptions, together with results of examination of 13 samples from druggists, page 50.

Specific gravity at 15° C.—The lowest specific gravity of any of the samples of probably pure olive oil (Tables XIX and XX), is .914. The maximum is .9181, or, excepting No. 6856, .9176.

Iodine number.—The lowest iodine absorption is 80.3, the highest 88.5, or, excepting No. 6856, 85.7.

Sample No. 6856 is stated to be a California olive oil and is of fine quality. The Bechi, Baudouin and Renard tests indicate the absence of cottonseed, sesame and peanut oils. The iodine number of pure olive oil is usually stated to be less than 84.5, but this limit is certainly too low. See page 48, No. 6856.

DeNegri and Fabris** state that an iodine number as high as 88 is no proof of adulteration, and the work of the California Experiment Station shows that the limit for olive oil produced in that State should be extended to at least 90. Paparelli†† found that six samples prepared at that Station had numbers ranging from 80.2 to 86.5. Among samples from other localities, two gave iodine absorption of 89.2 and 92.9, on which judgment was then reserved. Prof. Colby has kindly communicated later results obtained at the same Station with olive oil of undoubted purity which had an iodine absorption of 90.

Bechi test.—No color at all or only a slight color was produced in the oil.

Baudouin test.—The watery liquid became yellow in every case but three. In these a slight but distinct red color appeared. Further examination indicated that if sesame oil were present the quantity was inconsiderable.

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* U. S. Dept. Agr., Div. Chem., Bull. 13, Part IV, 462.

† See Rep. of this Station for 1896, p. 23.

‡ J. Am. Chem. Soc., xvii, 724.

§ Ztschr. f. das Chem. Grossgewerbe, 1878, 771.

‖ Ztschr. analyt. Chem., 23, 97.

¶ Ztschr. analyt. Chem., 33, 553.

** Chem. Ctrbl. 1891, lxii, Bd. ii, 87.

†† Cal. Ag. Ex. St. Rep., 1890, 173.

"Olive oil" adulterated with cottonseed oil.—Thirteen samples of this class (representing four brands sold in bottles and two in bulk) are tabulated in Table XXI, p. 51. All the labels are in the French language and declare the contents of the bottles to be olive oil.

Sample No. 6846 may have contained some olive oil, but the other samples probably contained no olive oil whatever, as they are quite like cottonseed oil in chemical and physical properties.

Excepting No. 6846, the sp. gr. at 15°C. ranged from .9219 to .9236, and the iodine number from 105.3 to 115.3. Bechi's test imparted to the fat a deep black color. The reaction with Baudouin's test showed absence of sesame.

Two samples adulterated with cottonseed oil were purchased of druggists. They were the following:

No. 6869, "Sweet oil.[*] Sold by W. N. Noble, New Milford. Price 15 cts. per 4 oz. bottle. This has the properties of pure cottonseed oil.

Sp. gr. at 15° C. .9238. Iodine number 108.5. Bechi test, deep black. Baudouin test, yellow.

No. 6931, "Olive oil." Sold at Starr's Drug Store, State St., New London. Price 20 cts. per 4 oz. bottle. This sample was rancid and wholly unfit for use.

Sp. gr. .9193. Iodine number 94.5. Bechi test, dark grey.

Olive oil adulterated with cotton seed oil may generally be detected by the taste. In addition to the absence of the very characteristic olive flavor, such oils often have the characteristic taste of cotton seed and when swallowed leave in the throat a slight irritation which lasts for a few minutes.

Salad oil consisting in part of cotton seed oil.—Table XXII describes nine samples of this kind, page 52.

In all cases "olive oil" was called for by the purchasing agent, but as the packages were labeled "salad oil," or "table oil," they cannot perhaps be classed as adulterated, though some acquaintance with the French language would be necessary in order to interpret their labels.

Olive oil adulterated with sesame oil.—One sample purchased at a grocery store and three from drug stores were found to contain appreciable quantities of sesame oil.

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[*] "Sweet oil," according to the U. S. Dispensatory, is a synonym of olive oil.

6850, "Italian Olive Oil." Sold by Edw. E. Hall & Son, grocers, 770 Chapel St., New Haven. Price 45 cents per pint bottle.

Sp. gr. at 15° C. .9176. Iodine number 88.0. Bechi test, no color. Baudouin test, on oil, deep red; on fatty acids, deep red.

6942, "Sweet Oil." Sold by John M. Brewer, druggist, Franklin square, Norwich. Price 25 cts. per 4 oz. Has the properties of sesame oil.

Sp. gr. at 15° C. .9232. Iodine number, 105.3. Bechi test, no color. Baudouin test, on oil, deep red; on fatty acids, deep red.

6948, "Pure Olive Oil." Sold by Merrill Bros., druggists, 48 E. Main St., Meriden. Price 15 cts. per 4 oz.

Sp. gr. at 15° C. .9182. Iodine number, 88.7. Bechi test, no color. Baudouin test, on oil, deep red; on fatty acids, deep red.

7003, "Finest Sweet Oil." Sold by Apothecaries Hall Co., Waterbury. Price 15 cts. per 4 oz.

Sp. gr. at 15° C. .9175. Iodine number, 88.4. Bechi test, no color. Baudouin test, on oil, deep red; on fatty acids, deep red.

TABLE XIX.—OLIVE OIL FROM GROCERS NOT FOUND ADULTERATED.

Station No.	Brand.	Dealer.	Price, cents, per 10 ounces.	Price per bottle.	Fluid Ounces of oil in bottle.	Specific gravity, 15° C.	Iodine number.	Bechi Test.	Baudouin Test.
6835	Antonini & Co., Extra Superfine Italian Salad Oil	L. D. Chidsey, cor. Church and George sts., New Haven	58	.35	6.0	.9158	84.0	Slight color	Yellow
6836	Barton & Guestier, Bordeaux, Huile d'Olive Superfine Clarifiée	Gilbert & Thompson, 918 Chapel st., New Haven	44	.75	17.0	.9157	84.6	"	"
6840	Fratelli Ricavi, San Cristoforo, Extra Lucca Oil	Maylinger & Hugo, 120 Crown st., "	38	.30	8.0	.9160	85.7	Grey	"
6841	J. B. & A. Artaud Frères, Marseille, Huile d'Olive Vierge	" " " "	55	.25	4.5	.9167	84.4	No color	"
6842	Lautier Fils, Huile Surfine d'Olive Vierge de Grasse	" " " "	43	.30	7.0	.9175	85.1	"	"
6848	Boutelleau Fils, Huile d'Olive	Edw. E. Hall & Son, 770 Chapel st., "	54	.75	14.0	.9176	83.9	"	"
6849	Quito Olive Farm, Santa Clara Co., Cal., Pure Olive Oil	" " " "	57	.60	10.5	.9165	84.8	Slight color	"
6856	Frank A. Kimball, National City, San Diego Co., Cal., Virgin Olive Oil	Johnson Bros., cor. State & Court sts., "	64	1.25	19.5	.9181	88.5	No color	"
6857	L. A. Price, Bordeaux, Huile d'Olive Vierge de Provence	" " " "	55	.60	11.0	.9167	83.7	Slight color	"
6858	Stable & Cie, Nice, Huile d'Olive	Harry Leigh, 354 State street, "	35	.60	17.5	.9155	84.8	No color	"
6859	S Rae & Co., Leghorn, Finest Sublime Lucca Oil	" " "	56	.25	4.5	.9163	81.6	Slight color	"
6864	D. G. Rosetti & Co, Leghorn, Italy, Extra Cream Lucca Olive Oil	T. W. Kinlin, New Milford	56	.25	4.5	.9167	82.9	No color	Slight red
6876	Julien Renan & Cie, Bordeaux, Huile d'Olive Extra Surfine	Newton Robertson & Co., Asylum st., Hartford	37	.40	11.0	.9163	82.0	Slight color	Yellow
6877	A. Fontenelle Fils & Cie, Grasse, Huile d'Olive Extra Surfine	J. P. Guilfoil, 193 Asylum street, "	63	.25	4.0	.9158	83.0	No color	"
6878	Marsalis & Cie, Bordeaux, Huile d'Olive Surfine Vierge	The Public Market, 217 Main street, "	35	.35	10.0	.9163	80.5	"	"
6879	Austin Nichols & Co., New York, Extra Cream Lucca Olive Oil, Leghorn	Allen Bros., 132 Main street, "	39	.35	9.0	.9165	81.6	Slight color	Slight red
6884	Eugene du Raix, Lucca, Huile d'Olive, Superfine, Doublement Clarifiée	Woodward & Co., 174 Asylum street, "	50	.25	5.0	.9168	82.2	Light grey	Yellow
6886	Hills & Co., Hartford, Huile d'Olive Superfine. Packed in France	Hills & Co., Asylum street, "	45	.25	5.5	.9165	82.4	Slight color	"
6894	John M. Chapman & Co., Importers, Cordon d'Argent Pure Olive Oil	D. M. Welch & Son, 212 Main st., New Britain	43	.45	10.5	.9161	82.2	"	"
6912	J. P. Fourché, Huile d'Olive de Nice	Dillon's Cash Grocery, E. Main st., Waterbury	56	.25	4.5	.9170	81.4	"	"

TABLE XIX.—OLIVE OIL FROM GROCERS NOT FOUND ADULTERATED.—*Continued.*

Station No.	Brand.	Dealer.	Price, cents, per 10 ounces.	Price per bottle.	Fluid Ounces of Oil in bottle.	Specific gravity 15° C	Iodine number.	Bechi Test.	Baudouin Test.
6913	Jas. G. Powers & Co., New York, Huile d'Olive Extra Superfine, Bordeaux	E. F. Platt, 39 E. Main street, Waterbury	53	.50	9.5	.9168	81.0	Slight color	Yellow
6914	Clark, Chapin & Bushnell, N. Y., Extra Quality Huile d'Olive Vierge, Bordeaux	N. W. Heater, N. Main street, "	41	.45	11.0	.9166	82 2	"	Slight red
6919	Gobelin Fils & Cie, Bordeaux, Huile d'Olive de Table, Extra Superieure	The Waterbury Grocery Co., 165 Bank street, Waterbury	41	.45	11.0	.9164	81.9	No color	Yellow
6921	Sold in wicker bottle, no label	Daboll & Freeman, 148 State st., New London	36	.25	7.0	.9158	82.6	Slight color	"
6926	Amorosi & Scopsi. Leghorn, Superfine Olive Oil	G. F. Barnstorf, 45 Main street, "	43	.30	7.0	9166	82.6	No color	"
6933	Bertrand Frères, Grasse, Huile d'Olive Extra Surfine	H. D. Avery, 202 Franklin street, Norwich	60	.30	5.0	.9166	81.9	"	"
6937	Anooil, Courbin & Co., Bordeaux, Huile d'Olive, Extra Superfine	Willard A. Church, 18 Market street, "	43	.75	17.5	.9163	85.2	Slight color	"
6941	Talbot Frères, Bordeaux, Huile d'Olive, Superfine Clarifiée	Burke & Haney, 263 E. Main street, "	56	.25	4.5	.9172	83.0	"	"
6944	Jeunes Plagniol, Extra Superfine, Huile d'Olive Vierge, France	City Meat Market, E. Main street Meriden.	29	.35	9.0	.9171	84.1	"	"
6945	Maurice O'Brien (Importer), Meriden, Huile d'Olive Superfine	" " " "	36	.35	13.5	.9172	81.9	"	"
6951	Sold in wicker bottle, no label	Samuel T. Camp, 234 Main st., Middletown	46	.30	6.5	.9166	81.1	"	"
6954	Beaumarchand Fils, Bordeaux, Huile d'Olive Vierge, Extra Superieure	Lawton & Wall, Main street, "	56	.25	4.5	.9167	84.2	Light grey	"
6957	Chas. Osgood & Co., Druggists, Norwich, Olive Oil	James Gleave, 905 Main street, Willimantic	38	.15	4.0	.9161	82.4	"	"
6958	R. de Servanes à Mouriés, Huile d'Olive Vierge Surfine	S. E. Amidon, 877 Main street, "	45	.20	4.5	.9166	84.7	No color	"
6961	W. H. Schieffelin & Co., N. Y., Lucca Cream Salad Oil, Bottled in Leghorn	Chas. R. Hibbard, 22 North st., "	53	.45	8.5	.9167	85.0	Slight color	"
7001	Alexis Godillot Jeune, Huile d'Olive Vierge Extra.	Henry Woodhull, cor. Main st., and South ave., Bridgeport	54	.27	5.0	.9167	83.2	"	"
6837	Luigi Baldocchi, Huile de Lucca. (Sold from tin can.)	F. Ferrino, 84 Oak street, New Haven	25	.20	8.0	.9162	83.7	Light grey	"

TABLE XX.—OLIVE OIL FROM DRUGGISTS NOT FOUND ADULTERATED.

Station No.	Dealer.	Price per 4 oz. with bottle.	Specific gravity at 15° C.	Iodine number.	Bechi Test.	Baudouin Test.
6832	W. A. Spaulding, 89 Church street., New Haven		.9140	84.4	No color.	Yellow
6833	" " " "		.9167	82.1	Slight color.	"
6905	H. A. Dupee, 59 Fairfield avenue, Bridgeport	.20	.9172	83.2	"	"
6906	F. S. Stevens & Co., Bridgeport	.30	.9164	83.2	No color.	"
6907	Apothecaries Hall, 17 Wall street, Bridgeport	.15	.9167	80.3	Slight color.	"
6927	C. M. Rogers, 9 Main street, New London	.20	.9169	82.6	"	"
6955	J. R. Pitt, Middletown	.15	.9161	83.2	"	"
6962	Frank M. Wilson, 133 Main street, Willimantic	.15	.9167	83.9	"	"
6963	T. Sisson & Co. 259 Main street, Hartford	.10*	.9164	83.9	"	"
6965	Park Drug Company, 376 Asylum street, Hartford	.10*	.9175	82.8	"	"
6968	Philo M. Newton, 142 Asylum street, Hartford	.15*	.9170	83.2	No color.	"
6964	S. P. Storrs, 297 Main street, New Britain	.15*	.9174	85.1	"	"
7002	G. Leslie Dexter & Co., Waterbury	.25	.9062	82.5	Slight color.	"

* For 2 oz. with bottle.

TABLE XXI.—"OLIVE OIL," ADULTERATED WITH COTTON SEED OIL.

(Bought of Grocers.)

Station No.	Brand.	Dealer.	Price per bottle.	Fluid Ounces of Oil in bottle.	Specific gravity at 15° C.	Iodine number.	Bechi Test.
6916	E. Loubon, Nice, Huile d'Olive Vierge (Red label)	Merrill's Cash Grocery, 266 N. Main street, Waterbury	$.15	7.0	.9230	114.8	Deep Black
6924	" " " " "	G. F. Barnstorf, 45 Main st., New London	.10	3.5	.9227	111.4	"
6946	" " " " "	Fred. H. Lewis. 98 W. Main st., Meriden	.10	3.0	.9228	112.3	"
6952	" " " " "	W. F. Ackley, Main street, Middletown	.10	3.0	.9226	111.4	"
6972	" " " " "	Henry Strack, 13 Shelton ave., New Haven	.08	3.0	.9226	115.3	"
6911	" " " " (White label)	160 Park ave, Bridgeport	.20	3.5	.9226	109.6	"
6971	R. L. Dacosini, Bordeaux, Huile d'Olive, Superfine Clarifiée	J. C. Kelley, cor. Munson st. and Dixwell ave., New Haven	.10	2.5	.9225	111.4	"
6895	R. L. Dacosini, Bordeaux, Huile d'Olive, Superfine Clarifiée	D. M. Welch & Son, 212 Main street, New Britain	.15	5.5	.9220	107.4	"
6902	B. Dufour & Cie, Bordeaux, Huile d'Olive, Luedeman's Brand	Grocery, cor. West and Railroad avenues, Bridgeport	.15	7.0	.9226	114.7	"
6940	Laurent Fréres, Bordeaux, Huile d'Olive, Superfine, Clarifiée Double	Burke & Haney, 263 E. Main st., Norwich	.05	2.5	.9224	109.6	"
6843	C. Cartoux, Nice, Huile d'Olive Vierge	Ed J. Bunce, 311 Congress avenue, New Haven	.15	7.0	.9229	109.1	"
6847	Sold in Bulk	M. Guldener, 146 George st., New Haven	.07	8.0	.9236	109.0	"
6846	" "	L. Grillo, Davenport ave., New Haven	.10	8.0	.9176	98.6	"

TABLE XXII.—"SALAD OIL," CONSISTING IN PART AT LEAST OF COTTON SEED OIL.

Station No.	Brand.	Dealer.	Price per bottle.	Fluid Ounces of Oil in bottle.	Specific gravity at 15° C.	Iodine number.	Bechi Test.
6844	E. Loubon, Superfine Huile Salad, Garantie, Marcadi Fabrica	F. H. Kearney, 74 Congress ave., New Haven	$.12	5 5	.9229	112.2	Deep Black
6970	E. Loubon, Superfine Huile Salad, Garantie, Marcadi Fabrica	C. Kipp, 288 Dixwell ave., New Haven	.10	3.5	.9230	112.2	"
6922	E. Loubon, Nice, Best Table Oil	Keefe & Davis, 125 Bank st., New London	.15	3.0	.9219	110.1	"
6834	L. Verona, Huile Salade, Superfine. Doublement Clarifiée	P. Jente & Bro., Broadway, New Haven	----	9.0	.9230	108.8	"
6935	Union Oil Co., Providence, R. I., Providence Pure Salad Oil	J. T. Powers, 363 E. Main st., Norwich	.20	5.5	.9219	113.0	"
6880	Union Oil Co., Providence, R. I., Providence Pure Salad Oil	Allen Bros., 132 Main street, Hartford	.10	5.0	.9220	109.0	"
6934	Imperial Huile à Salade, Nantes	H. D. Avery, 202 Franklin st., Norwich	.20	4.5	.9225	111.0	"
6925	Joseffo Mazzini, Nice, Huile de Salade d'Aix	G. F. Barnstorf, 43 Main st., New London	.10	3.0	.9219	113.2	"
6908	F. A. Osten, Huile de Salade, Clarifiée Superfine, Providence,	The White Star Market, cor. Broad st. and Railroad ave., Bridgeport	.10	3.0	.9226	105.3	"

MARKET MILK.

Samples Collected by Station Agents.

By A. L. Winton, A. W. Ogden and W. L. Mitchell.

During October and November, 1896, 146 samples of market milk were collected by agents of the Station. These samples were taken in the following places:

	From Milk Wagons.	From Groceries.	Total.
Bridgeport	13	4	17
Hartford	20	8	28
Meriden	9	1	10
New Haven	50	9	59
New London	4	5	9
Norwich	1	3	4
Waterbury	12	1	13
Willimantic	4	2	6
Totals	113	33	146

The samples from milk wagons were bought in the morning between the hours of four and eight o'clock, wherever the wagons were found on the streets. Samples from groceries were bought a little later in the day.

In Tables XXIII and XXIV are given names, initials, etc., found on the wagons. See pages 55, 56, 57.

Specific gravity, solids and fat were determined in all these samples and test was made for the presence of borax.

The results of these examinations appear in detail in following Tables, XXIII and XXIV, and may be summarized as follows:

Milk bought from milk wagons.—The maximum and minimum percentages of solids and fat found in the milk examined were as follows:

	Solids		Fat	
	Highest.	Lowest.	Highest.	Lowest.
Bridgeport	14.4	11.9	5.4	3 3
Hartford	14.9	12.0	5.3	2.7
Meriden	13.8	12.4	4.5	3.8
New Haven	14.9	9.1	4.8	.5
New London	13.7	12.1	4.7	3.0
Waterbury	13.9	12.4	5.3	3.7
Willimantic	14.1	12.8	5.1	4.1

All the samples of milk bought of milkmen in Meriden, Waterbury and Willimantic contained more than 12.0 per cent. of solids, and 3.5 per cent. of fat.

Of the thirteen samples bought in Bridgeport a single one contained but 11.90 per cent. of solids and 3.3 per cent. of fat, while in all the others the percentages of solids and fat were above 12 and 3.5 respectively.

In Hartford, of the twenty samples none contained less than 12 per cent. of solids. Three had less than 3.5 per cent. of fat and two of these, having high specific gravities, 1.034 and 1.0342, and very low percentages of fat, 2.9 and 2.65, had probably been partially skimmed.

Of the fifty samples bought in New Haven five had less than 12 per cent. of solids and the same number less than 3.5 per cent. of fat. Of these, two were obviously skimmed milk, containing only 0.5 per cent. of fat. The third was watered, containing 10.52 per cent, of solids and 2.4 per cent. of fat.

Two samples, one bought of J. H. Dore, Oct. 22, and one of Ziegler on Oct. 19, contained *borax*, and were the only ones taken in 1896 in which this antiseptic was found.

One sample from New London had but 3 per cent. of fat but was good otherwise.

The single sample bought in Norwich was of very poor quality and probably watered.

Of 113 samples which were bought in the autumn from milk wagons in the eight cities named, 4 were more or less skimmed, 1 was watered, 1 is suspected of being watered, and 2 contained borax.

Milk bought from groceries.—Of the thirty-three samples none contained borax and only a single one was inferior (11.29 per cent. of solids and 3.2 per cent. of fat).

While the number of samples examined is not large, it is sufficient to show that in the months of October and November, 1896, the general character of the milk supply was satisfactory for the most part, but 9 samples out of 146 being inferior or adulterated.

TABLE XXIII.—ANALYSES OF MILK BOUGHT FROM MILK WAGONS.

Date.		Names, Initials, etc., on Wagons.	Price per pint. Cents.	Sp. gr.	Solids.	Fat.
		BRIDGEPORT.				
Oct.	28	E. B. Andrews	3	30.5*	14.23	5.0
Nov.	20	C. E. B.	3	32.	12.82	4.1
Oct.	28	A. F. Berger	4	29.	13.30	4.4
"	28	John Clancy	3	29.5	14.40	5.4
"	28	Farrar	3	30.6	13.10	4.2
"	28	S. Jennings & Son	4	31.2	13.70	4.4
"	28	M. J. Kelly	3	29.5	12.80	4.0
"	28	A. F. Linley	3	29.0	12.30	3.9
"	28	C. G. Miller	3	30.6	13.30	4.2
"	28	S. Thorpe	3	25.2	11.90	4.2
"	28	E. B. W.	3	32.0	13.50	4.4
"	28	H. L. Wilson	3	28.7	11.90	3.3
"	28	No. 64	3	30.6	12.30	3.4
		HARTFORD				
Nov.	10	Akerburg Bros.	4	30.7	14.52	5.0
"	10	M. Barber	4	30.0	12.04	3.6
"	10	W. W. Barber	4	31.8	13.77	4.5
"	10	L. H. Barnard	4	32.8	12.62	3.3
"	17	E. Bolze, Newington	4	27.4	13.70	5.3
"	10	O. A. Chapman	4	31.0	13.87	5.1
"	17	D. Flynn	3	26.2	12.30	4.1
"	10	W. O. Griswold	4	31.5	13.42	4.3
"	17	W. F. Haynes	4	29.2	12.90	4.2
"	10	Hans Jepson	4	31.7	14.93	5.0
"	10	—— Mortensen	4	31.0	12.71	3.6
"	10	D. Moylan	4	34.0	12.60	2.9
"	10	N. O. Peterson	4	31.3	13.10	3.7
"	17	John A. Pilgard	3	34.2	12.40	2.65
"	10	C. H. Rood	4	31.8	12.54	3.20
"	10	J. B. Root	4	30.8	13.65	4.40
"	10	F. A. Rudolph, Ag't	4	30.6	13.53	3.90
"	10	R. W.	4	27.5	12.43	4.20
"	17	No mark. Pleasant St.	3	29.1	13.50	4.85
"	17	License 100, Bloomfield	4	28.9	13.30	4.3
		MERIDEN.				
Oct	30	W. R. Carver	4	29.3	13.32	4.3
"	30	Dickerman Bros.	3	28.4	12.45	3.8
"	30	D. Higgins	4	30.3	13.58	4.4
"	30	Wm. Johnson	3	30.3	13.79	4.5
"	30	Chas. Kiffmeyer	4	30.3	13.35	4.4
"	30	J. J. Schwink	4	31.3	13.18	3.8
"	30	A. J. Schourock	4	30.3	12.72	3.8
"	30	S. R. Waterman	4	27.4	12.47	4.3
"	30	E. H. Yale & Son	3	29.2	13.38	4.4
		NEW HAVEN.				
Oct.	23	J. E. A.	3	30.4	13.51	4.3
"	19	Allen	3	29.7	13.40	4.3
"	22	W. G. Arents	3	30.2	14.87	6.1
"	19	D. W. B.	3	29.7	13.2	4.2
"	23	O. B.	3	30.2	12.56	3.7
"	22	Betticol	3	28.9	14.8	5.2
"	26	C. W. Brock	3	29.0	12.75	4.2
"	23	R. Buckler	3	28.2	14.87	6.1
"	19	E. T. C.	3	30.7	13.6	4.3
"	26	H. W. C.	3	30.0	12.94	4.2
"	24	H. S. Dailey	3	30.6	11.80	3.2
"	21	J. E. D.	3	28.9	13.1	4.2
"	22	J. H. Dore	3	26.2	11.8	3.4
"	26	Elm Glen Dairy	3	27.3	11.29	3.5
"	24	Grannis Corner Dairy	3	30.6	13.71	4.7

* Read 1.0305.

TABLE XXIII.—ANALYSES OF MILK BOUGHT FROM MILK WAGONS —*Continued.*

Date.		Names, Initials, etc., on Wagons.	Price per pint. Cents.	Sp. gr.	Solids.	Fat.
		NEW HAVEN—*Continued.*				
Oct.	19	E. H. E.	3	30.7	13.2	4.2
"	23	Spring Glen Farm	3	30.6	13.88	4.3
"	21	" " "	3	31.0	13.10	4.2
"	26	O. H.	3	28.6	13.50	4.3
"	19	F. H.	3	30.9	13.8	4.5
"	26	F. H.	3	30.½	13.24	4.1
"	19	—— Hazelton	3	31.2	14.3	4.7
"	24	C. W. J.	3	29.6	12.06	3.5
"	19	S. Jacobson	3	28.7	13.1	4.5
"	21	C. A. Kirk	3	30 7	13.4	4.2
"	23	A. S. L.	3	30.4	12.64	4.0
"	19	A. S. L.	3	29.7	13.2	4.2
"	23	G. L. Noble	3	30.2	13.33	4.2
"	26	—— Osborn	3	31.0	13.03	3.7
"	19	—— Osgoe	3	30.7	13.5	4.0
"	23	H. F. P.	3	27.4	12.25	3.6
"	26	H. F. P.	3	27.0	12.82	3.9
"	23	E N. Pettit	3	30.6	12.69	3.8
"	19	—— Pohlman	3	29.7	12.7	4.0
"	23	—— Russell	3	31.6	12.77	3.6
"	21	S.	3	29.7	14.4	4.8
"	26	A. L. S.	3	28.4	12.76	3.9
"	23	E. Shea	3	29.6	12.38	3.8
"	23	—— Simes (Hamilton St.)	3	29.6	10.52	2.4
"	19	—— Smith	3	30.7	13.3	4.0
"	19	C. E. Smith	3	29.6	12.3	3.6
"	24	—— South	3	28.8	12.86	4.3
"	19	E. S. T.	3	30.7	12.9	4.0
"	23	—— Tart	3	29.6	12.89	4.0
"	24	Valley Farm Creamery	3	30.0	13.59	4.3
"	19	" " "	3	31.7	9.1	0.5
"	23	" " "	3	32.6	9.25	0.5
"	24	—— Warner	3	32.6	13.68	4.2
"	19	—— Ziegler	3	30.7	12.7	3.6
"	19	"	3	31.7	13.2	3.8
		NEW LONDON.				
Oct.	29	H. W. H.	3	28 4	13.7	4.7
"	29	Oakland Farm Dairy	3	30.8	12.1	3.0
"	29	N. A. Richards	3	29.3	12 3	3.5
"	29	N. Stenzer	3	27.4	13.13	4.7
		NORWICH.				
Oct.	29	C. B. Chapman	3	30.6	11.1	2.4
		WATERBURY.				
Oct.	27	Atwood Bros.	3	28.7	12.5	3.8
"	27	H. E. Barnes, Watertown	3	28.5	13.7	4.7
"	27	S. P. Bronson	4	29.5	13 3	4 3
"	27	Wm. A. Faber	3	29 5	12.5	3.7
"	27	—— Lockwood	3	30.3	13.5	4 5
"	27	C. B. Mattoon	3	29.2	13.3	3.9
"	27	S. R. Middlebury	3	29.2	13.2	4.3
"	27	E. Moriarty	4	29.5	12.4	3.8
"	27	W. J. Munson, Watertown	3	31.0	13.3	4.2
"	27	P. A. Patterson, Oakville	3	29.1	13.0	3.8
"	27	—— Schittler	4	27.3	13.9	5.3
"	27	J. M. Slocum	4	30.0	13.7	4.6
		WILLIMANTIC.				
Nov.	18	Oak Pond Creamery	3	26.6	13.48	5.1
"	18	E. W. Ellison	3	31.5	13.57	4.1
"	18	Pleasant Valley Farm	3	29.6	14.09	5.0
"	18	—— Stearns	4	29.5	12.76	4.1

TABLE XXIV.—ANALYSES OF MILK BOUGHT FROM GROCERIES.

Date.	Dealer.	Price per pint. Cents.	Sp. gr.	Solids.	Fat
	BRIDGEPORT.				
Nov. 20	W. G. & E. W. Lewis, 284 Main St.	3	31.2	12.47	3.9
" 20	G. A. Robertson, 70 State St,	3	30.2	12.0	3.9
" 20	—— Zimmerman, 39 Fairfield Ave.	3	31.5	14.37	5.4
" 20	Cor. Crescent Ave. and Harriet St.	4	28.8	12.78	4.6
	HARTFORD.				
Nov. 17	B. Blumenthal, 229 Market St.	3	26.2	17.4	8.0
" 17	M. J. Feeley, 26 Front St.	3	29.5	13.9	5.0
" 17	Joseph Hagerty, 75 Front St.	4	27.	11.9	4.2
" 17	H. Jonas, 60 Temple St.	4	31.3	12.2	3.4
" 17	J. Malley, 137 Front St	3	29.	12.9	4.3
" 17	Nicholas Pollotti, 67 Morgan St.	3	29.5	13.6	4.8
" 17	M. Rosenblatt, 44 Village St.	4	29.7	13.7	4.8
" 17	Jacob Walz, 54 Temple St.	4	26.3	11.3	3.7
	MERIDEN.				
Oct. 30	D. Higgins, 17 Butler St. (Milk Depot).	4	26.3	14 37	6.0
	NEW HAVEN.				
Oct. 22	F. A. Bassermann, 627 Grand Ave.	3	28.9	12.1	3.1
" 24	C. F. Clark, cor. Elm and Park	3	31.6	12.64	3.6
" 22	Patrick McCabe, 660 Grand Ave.	3	27.	13.3	5.0
" 24	C. Reed & Son, cor. Webster and Goffe Sts.	3	28.6	11.29	3.2
" 19	—— ——, 470 Congress Ave.	3	29.7	13.9	5.2
" 24	—— ——, cor. Goffe and Orchard Sts.	3	28.6	12.37	5.1
" 19	—— ——, 676 Grand Ave.	3	31.7	13.0	3 8
" 19	—— ——, 840 " "	2	26.8	11.6	3.7
" 24	—— ——, 63 Whalley Ave.	3	32.1	12.94	3.9
	NEW LONDON.				
Oct. 29	Thos. W. Gardner, 3 State St.	3	29.5	12.3	3.5
" 29	John Rollo, 70 Main St.	3	30.	16.5	5.6
" 29	C. E. Williams, 20 Main St.	3	29.5	12.9	4.1
" 29	—— ——, 17 State St	4	29.5	13.9	4.8
" 29	N. Y. Cash Grocery, 407 Bank St.	3	29.5	15.0	5.7
	NORWICH.				
Oct. 29	J. A. Stoddard, 106 Franklin St.	3	31.	12.2	3.4
" 29	Sweet's Market, 94 Franklin St.	3	29.5	12.1	3.6
" 29	Elijah Tracy, 127 W. Main St.	3	28.6	14.0	5.3
	WATERBURY.				
Oct. 27	Ball's Milk Office, 7 Spring St.	3	29.7	13.5	4.3
	WILLIMANTIC.				
Nov. 18	C. M Thompson, 901 Main St.	3	27.5	14 18	6.2
" 18	G. A. Tracy, Main St.	3	29.6	12.24	3.4

EXAMINATION OF SAMPLES OF MILK SENT BY THE BRIDGEPORT BOARD OF HEALTH.

BY W. L. MITCHELL.

In Table XXV are given the analyses of forty-eight samples of milk sent to the Station by Dr. Sheedy of the Board of Health of Bridgeport, in August, 1897. The samples were taken by agents of the Board and are stated to represent milk bought of milkmen in that city.

Of the 48 samples, 35 contained over 12 per cent. of solids and 3.5 per cent. of fat. Four others, Nos. 15, 16 and 23 of Aug. 12, and No. 17 of Aug. 13, could scarcely be called inferior in quality, although they contained somewhat less than 12 per cent. of solids.

Of the others, four samples, No. 10 of Aug. 12, and Nos. 18, 19 and 24 of Aug. 13, had been without doubt watered. The five remaining samples, Nos. 3, 6, 14 and 19 of Aug. 12, and No. 3 of Aug. 13, were inferior in quality, not adulterated.

Sample No. 8, Aug. 13, was evidently cream.

TABLE XXV.—MILK SUBMITTED BY BRIDGEPORT BOARD OF HEALTH.

No.	Date.	Specific Gravity.	Solids.	Fat.	No.	Date.	Specific Gravity.	Solids.	Fat.
1	Aug. 12	29.8*	12.28	4.1	1	Aug. 13	29.1	12.28	3.8
2	" 12	29.7	13.56	4.9	2	" 13	32.	12.89	4.1
3	" 12	30.9	11.80	3.2	3	" 13	28.	11.55	3.6
4	" 12	30.8	13.93	5.2	4	" 13	31.	12.71	4.1
5	" 12	30.9	12.88	4.2	5	" 13	31.4	13.11	4.4
6	" 12	30.9	11.68	3.3	6	" 13	28.4	12.61	4.2
7	" 12	29.7	12.67	4.2	7	" 13	30.3	12.12	3.6
8	" 12	32.0	12.80	4.0	8	" 13	---	23.49	18.0
9	" 12	31.2	12.26	3.7	9	" 13	31.3	14.66	5.5
10	" 12	27.0	10.32	2.7	10	" 13	32.2	12.52	3.7
11	" 12	30.2	12.53	4.0	11	" 13	31.7	13.66	4.6
12	" 12	29.4	13.54	4.8	12	" 13	30.7	13.73	5.1
13	" 12	29.4	12.71	4.4	13	" 13	30.	12.75	4.2
14	" 12	28.2	11.13	3.2	14	" 13	29.8	12.27	4.2
15	" 12	28.1	11.79	3.8	15	" 13	30.1	12.89	4.4
16	" 12	30.3	11.96	3.4	16	" 13	28.3	13.21	5.2
17	" 12	28.3	12.12	3.9	17	" 13	29.	11.78	3.6
18	" 12	29.2	12.17	4.0	18	" 13	23.6	10.15	3.5
19	" 12	29.4	11.09	3.2	19	" 13	25.8	10.31	3.0
20	" 12	31.0	13.53	4.6	20	" 13	30.1	13.15	4.5
21	" 12	30.3	13.88	5.2	21	" 13	31.1	12.58	4.0
22	" 12	30.2	13.80	5.0	22	" 13	31.2	12.70	3.8
23	" 12	29.5	11.79	3.6	23	" 13	30.1	13.27	4.4
24	" 12	29.5	12.88	4.4	24	" 13	28.7	10.70	2.8

* Read 1.0298.

EXAMINATION OF MILK SUPPLIED TO A PUBLIC INSTITUTION.

BY E. H. JENKINS.

The following experience illustrates the fact that the milkman is not always responsible for the quality of the milk which reaches the tables of his customers.

One of the State institutions purchases milk under a guarantee of four per cent. of butter fat as the minimum limit.

Early in the year the Station was asked to examine the milk, as it seemed poor in quality.

Minute instructions were given as to the method of taking the samples, which were drawn by an employee and stated to be drawn very early in the morning before any milk was taken out for use. These samples, six in number, representing between 200 and 300 quarts of milk, mostly contained not far from four per cent. of fat, one or two of them, however, considerably less. The milk dealer was warned that the milk was not up to the quality contracted for. He stated that the milk was tested from time to time by him with the Babcock tester and he had never found such low percentages as were reported from the above examination.

Several weeks later an agent of the Station intercepted the milk wagon as it was entering the grounds of the institution at 5 A. M., and carefully sampled the contents of each can on the cart. The wagon delivered the full cans and left the grounds with empty cans.

Shortly before dinner time and again before supper time, on the same day, the agent visited the institution and took samples from the milk as it was delivered for the use of the inmates.

The results of analyses, made by Mr. Ogden, appear in the following table:

Percentages of Fat in the Milk as delivered by milkman.	Percentages of Fat in the Milk served out at dinner.	Percentages of Fat in the Milk served out at supper.
5.8	3.25	3.70
5.8	2.7	3.95
5.55	3.2	4.20
5.0	3.05	3.70
5.25	3.90	4.40
	3.95	4.15

It appeared that some one, possibly without knowledge of the effect on the quality of the remaining milk, had poured off from the tops of the cans for certain kitchen uses and then poured out the remaining milk as it was required, *always without stirring!*

This state of things when once discovered was immediately remedied and occasional examination of the milk delivered by the milkman and of that served to the inmates, strengthens the good intentions of all persons concerned.

FOOD PRODUCTS EXAMINED FOR THE DAIRY COMMISSIONER IN THE YEAR ENDING JULY 31, 1897.

By E. H. Jenkins.

A considerable part of the chemical and polariscopic work here described was done by Messrs. Winton, Ogden and Mitchell.

All adulterated samples were also examined by Mr. Jenkins, who was summoned to attend court cases of prosecution for violation of the law. Without exception, the defendants have declined to stand trial and have settled out of court.

Vinegar.

Thirty-five samples sent by the Dairy Commissioner were marked, and by the dealers claimed to be, "cider vinegar."

Standard Cider Vinegar.—The State law requires that all vinegar sold as cider vinegar shall contain not less than two per cent. of solids and not less than four per cent. of acetic acid.

Solids. Of the samples marked cider vinegar
3 had less than 0.50 per cent. of solids.
2 " between 0.50 and 1.00 per cent. of solids.
2 " " 1.50 " 1.75 " "
2 " " 1.75 " 2.00 " "
26 " over 2 per cent. of solids.
The highest percentage found was 4.25.

Acidity.

1 had less than 1.0 per cent. of acidity.[*]
1 " between 2.0 and 3.00 per cent. of acidity.
1 " " 3.0 " 3.50 " "
6 " " 3.5 " 4.00 " "
26 " over 4.0 per cent. of acidity.
The highest percentage found was 5.85.

Four samples marked "White Wine Vinegar" contained from 0.02 to 0.43 per cent. of solids and from 3.41 to 3.95 per cent. of acidity.

With one exception, the other samples, twenty-six in number, received from the Dairy Commissioner without special marks, contained more than the amount of acetic acid which is required by law.

MOLASSES.

One hundred and ninety-two samples of molasses and syrups have been examined in the year ending July 31, 1897.

Method of Examination.—13.024 grams (one-half the normal weight) of molasses were dissolved in about 80 cc. of water, 3 cc. of basic lead acetate were added, the volume was made up to 100 cc. and the whole was thoroughly mixed and passed through a dry filter. The rotation of the clear and nearly colorless filtrate was determined, in a 200 mm. tube, with a Schmidt and Haensch half shade double compensation polariscope. The reading, doubled, gave the sugar degrees or per cent. No correction was attempted for the volume of the lead precipitate.

To 50 cc. of the filtrate referred to above, were added 5 cc. conc. C. P. hydrochloric acid and after thorough mixing, the flask containing the solution was placed in a cold water bath which was then quickly heated to 68° C. After standing at that temperature for 10 minutes, the contents of the flask were quickly cooled and the solution, filtered from lead chloride when necessary, was examined in a 220 mm. tube, provided with a water jacket. The temperature was noted with the reading. This reading, doubled, gave the sugar degrees after inversion.

Water, heated to 86° C., was then passed through the jacket and a third reading made at that temperature.

The rotatory power of dextrose is not greatly affected by the temperature, but that of levulose diminishes as the temperature rises, so that invert sugar becomes practically inactive at about 86°.

Results of Examination.—Of the 192 samples of molasses and syrups examined for the Dairy Commissioner, 63 were adulterated with glucose syrup and 129 were free from this adulterant.

Molasses.—The behavior of molasses unadulterated with glucose, when examined by the method above given, is seen from the following figures obtained on a few of the 129 samples:

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[*] Calculated as acetic acid.

TABLE XXVI.—POLARIZATION OF MOLASSES.

Label.	Direct Reading.	After Inversion Reading.	After Inversion Temperature.	Reading at 86°.
"Rock Candy Syrup"	65.2	−20.4	24°	....
New Orleans Molasses	38.0	−20.1	27	−5.2
" " "	48.8	−16.8	24	....
" " "	51.4	−16.8	26	....
" " "	54.3	−10.0	24	....
" " "	44.8	−18.7	25	...
Ponce "	46.9	−15 0	--	....
" "	52.6	−12.0	--	....
Porto Rico "	43.4	−16.8	24	....
" " "	51.4	−13.8	27	....
No marks	52.8	−15.8	22	+3.0
	51.6	−15.0	22	+0.8
	53.3	−14 9	25	+0.1
	52.2	−16.6	24	0.0
	52.8	−14.0	28	+0.6
	52.3	−12.6	27	+0.6

Adulterated Molasses.—The 63 samples of adulterated molasses were labeled New Orleans, Porto Rico, Syrup, etc., but the Station has no further information regarding their character or sources.

The results of their examination are summarized as follows:

TABLE XXVII.—POLARIZATION OF ADULTERATED MOLASSES.

	Direct reading.	Readings after Inversion. At room temp.	Readings after Inversion. At 86° C.
6 samples	121.6–136.2	90.4–126.1	91.6–115.8
9 "	110.2–117.0	89.4–103.4	84.2–101.4
14 "	100.6–109.6	64.9–100.7	79.0– 92.2
6 "	90.0– 98.4	50.2– 76.2	52.4– 76.8
19 "	80.4– 89.2	20.7– 60.4	22.5– 64.6
2 "	71.8– 76.8	30.6– 32.5	....
5 "	61.8– 68.0	9.0– 26 8	11.5– 37.8
1 "	55.4	00	15.0 ....
1 "	47.6	6.4	16 4 ....
63			

The last two given above, were the only adulterated samples whose polarization before inversion was under 60 sugar degrees.

BUTTER AND OLEOMARGARINE.

Twenty samples have been examined for the Dairy Commissioner during the year ending July 31, 1897.

Methods of Examination.

Specific Gravity.—This is determined at the temperature of boiling water by means of Westphal's balance, as first described by Estcourt and by J. Bell, Chem. News, Vols. xxxiv. 254 and xxxviii. 267.

The balance is so adjusted that water at 15.5° C. shall represent unity.

With distilled water, at the temperature of boiling, the instrument indicates a specific gravity of .9625. If the specific gravity of fat at the temperature of boiling water is desired, using the weight of an equal volume of distilled water *at that temperature* as a standard, the reading of the instrument must be multiplied by 1.039.

We have also used for this determination a specific gravity spindle made by Greiner of New York City, 6⅝ inches long, reading from .8550–.8700 and graduated to show differences of .0005 in sp gr.

Volatile Fatty Acids—These were determined by the Reichert method, the saponification being effected by the method of Leffmann and Beam, as described in the Analyst, xvi. 1891, p. 153. The result of the determination is expressed by the number of cubic centimeters of $\frac{1}{10}$ normal sodium hydroxide solution necessary to neutralize the acid distilled from 2.5 grams of the fat.

Results of Examination.

Of the samples, 18 were butter and 2 were imitation butter or oleomargarine.

The specific gravity of the melted fat, determined by the method above named, in the samples of butter, ranged from .8645 to .867.

In the samples of imitation butter or oleomargarine, from .8596 to .8615.

The volatile fatty acids determined as above described, in 2.5 grams of butter, ranged from 13.0^{cc} to 16.9^{cc}. In the like quantity of imitation butter they ranged from 0.31^{cc} to 2.11^{cc}.

CREAM.

Three samples of cream, submitted for test by the Dairy Commissioner, were stated to be drawn from stock of E. E. Philbrick, Whiting street, New Haven. All of these samples contained *borax.*

SUMMARY.

The following table contains a summary of the results of the work done during the past year in the Examination of Food Products:

	Number of Samples not found to be adulterated.	Number of Samples found to be adulterated.	Number of Samples containing borax, salicylic acid or benzoic acid.	Total.
COLLECTED BY THE STATION.				
Black Pepper	30	15	..	45
White Pepper	4	1	..	5
Cayenne Pepper	18	12	..	30
Allspice	13	11	..	24
Cinnamon or Cassia	26	8	..	34
Cloves	20	17	..	37
Coffee	30	41	..	71
Date Stone Coffee	..	..	..	1
Catsup	6	..	35	41
Chili Sauce	..	..	1	1
Honey	1	..	..	1
Maple Syrup	3	..	..	3
Confectionery	30	..	..	30
Sausage	15	..	27	42
Mince Meat	5	..	..	5
Head Cheese	1	..	1	2
Codfish	..	..	11	11
Olive Oil	55	26	..	81
Oysters	62	..	13	75
Milk	203	12	2	217
Total	522	143	90	756
COLLECTED BY DAIRY COMMISSIONER.				
Vinegar	..	..	..	65
Molasses and Syrups	129	63	..	192
Butter and Imitation Butter	18	2	..	20
Cream	..	..	3	3
SENT BY OTHER INDIVIDUALS.				
Molasses	7	1	..	8
Milk	14	..	..	14
Cream	5	..	..	5
Total from all sources	695	209	93	1063

COMMERCIAL FERTILIZERS.

During 1897 fifty-six manufacturing firms have entered for sale in this state two hundred and eighty-one distinct brands of fertilizers, viz :

Special manures for particular crops	102
Other nitrogenous superphosphates	111
Bone manures and "bone and potash"	39
Chemicals, including fish, tankage and castor pomace	29
	281

The duties of this Station regarding fertilizers are prescribed by law as follows :

THE FERTILIZER LAW OF CONNECTICUT.

The General Assembly, in 1882, passed an Act concerning Commercial Fertilizers, which, as amended in 1893, is now in force.

Attention is especially called to the following requirements of the law, the full text of which is printed on pages 67 and 68.

1. In case of *all* fertilizers or manures, except stable manure and the products of local manufactures of less value than ten dollars a ton, the law holds the SELLER responsible for *affixing a correct label or statement* to every package or lot sold or offered, as well as for the *payment of an analysis fee* of ten dollars for each fertilizing ingredient which the fertilizer contains or is claimed to contain, *unless* the MANUFACTURER OR IMPORTER has provided labels or statements and has paid the fee. Sections 4005 and 4007.

The Station understands "the fertilizing ingredients" to be those whose determination in an analysis is necessary for a valuation, and which are generally Nitrogen, Phosphoric Acid and Potash. The analysis fees in case of any fertilizer will therefore usually be ten, twenty or thirty dollars, according as one, two or three of these ingredients are contained or claimed to exist in the fertilizer.

2. The law also requires, *in the case of every commercial fertilizer*, that a *sealed sample* shall be deposited with the Director of the Station by the MANUFACTURER OR IMPORTER, and that a *certified statement* of composition, etc., shall be filed with him. Section 4006.

A statement of the per cent. of Nitrogen, Phosphoric Acid (P_2O_5) and Potash (K_2O), and of their several states or forms, will suffice in most cases. Other ingredients may be named if desired.

In all cases the per cent. of *nitrogen* must be stated. Ammonia may also be given when actually present in ammonia salts, and "ammonia equivalent to nitrogen" may likewise be stated.

The per cent. of soluble and reverted phosphoric acid may be given separately or together, and the term "available" may be used in addition to, but not instead of, soluble and reverted.

The percentage of insoluble phosphoric acid may be stated or omitted.

In case of Bone, Fish, Tankage, Dried Meat, Dried Blood, etc., the chemical composition may take account of the two ingredients: Nitrogen and Phosphoric Acid.

For Potash Salts give always the per cent. of Potash (potassium oxide): that of Sulphate of Potash or Muriate of Potash may also be stated.

The chemical composition of other fertilizers may be given as found in the Station Reports.

3. It is also provided that EVERY PERSON in the State, who sells *any commercial fertilizer of whatever kind or price*, shall annually report certain facts to the Director of the Experiment Station, and on demand of the latter shall deliver a sample for analysis. Section 4008.

4. All "CHEMICALS" that are applied to land, such as Muriate of Potash, Kainite, Sulphate of Potash and Magnesia, Sulphate of Ammonia, Nitrate of Potash, Nitrate of Soda, etc.—are considered to come under the law as "Commercial Fertilizers." Dealers in these chemicals must see that packages are suitably labeled. They must also report them to the Station, and see that the analysis fees are duly paid, in order that the Director may be able to discharge his duty as prescribed in Section 4013 of the Act.

It will be noticed that the State exacts no license tax either for making or dealing in fertilizers. For the safety of consumers and the benefit of honest manufacturers and dealers, the State requires that it be known what is offered for sale, and whether fertilizers are what they purport to be. With this object in view the law provides, in Section 4013, that all fertilizers be analyzed, and it requires the parties making or selling them to pay for these analyses in part; the State itself paying in part by maintaining the Experiment Station.

ACTS CONCERNING COMMERCIAL FERTILIZERS.

Chapter CCLIII of the General Statutes of Connecticut as amended by Chapter CLXXII of the Acts of the General Assembly, Session of 1893.

SECTION 4005. Every person or company who shall sell, offer, or expose for sale, in this State, any commercial fertilizer or manure except stable manure, and the products of local manufacturers of less value than ten dollars a ton, shall affix conspicuously to every package thereof a plainly printed statement clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand, or trade-mark under which the fertilizer is sold, the name and address of the manufacturer, the place of manufacture and the chemical composition of the fertilizer, expressed in the terms and manner approved and usually employed by the Connecticut Agricultural Experiment Station.

If any such fertilizer be sold in bulk, such printed statement shall accompany every lot and parcel sold, offered or exposed for sale.

SEC. 4006. Before any commercial fertilizer is sold, offered, or exposed for sale, the manufacturer, importer or person who causes it to be sold, or offered for sale, within this State, shall file with the Director of the Connecticut Agricultural Experiment Station two certified copies of the statement prescribed in section 4005, and shall deposit with said director a sealed glass jar or bottle containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

SEC. 4007. The manufacturer, importer, agent, or seller of any commercial fertilizer shall pay on or before May 1, annually, to the Director of the Connecticut Agricultural Experiment Station, an analysis fee of ten dollars for each of the fertilizing ingredients contained or claimed to exist in said fertilizer: *provided*, that when the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee prescribed in this section.

SEC. 4008. Every person in this State who sells, or acts as local agent for the sale of any commercial fertilizer ot whatever kind or price, shall annually, or at the time of becoming such seller or agent, report to the Director of the Connecticut Agricultural Experiment Station his name and brand of said fertilizer, with the name and address of the manufacturer, importer or party from whom such fertilizer was obtained, and shall, on demand of the Director of the Connecticut Agricultural Experiment Station, deliver to said director a sample suitable for analysis of any such fertilizer or manure then and there sold or offered for sale by said seller or agent.

SEC. 4009. No person or party shall sell, offer, or expose for sale, in this State, any pulverized leather, raw, steamed, roasted, or in any form, as a fertilizer or as an ingredient of any fertilizer or manure, without explicit printed certificate of the fact, such certificate to be conspicuously affixed to every package of such fertilizer or manure, and to accompany every parcel or lot of the same.

SEC. 4010. Every manufacturer of fish guano, or fertilizers of which the principal ingredient is fish or fish mass from which the oil has been extracted, shall, before manufacturing or heating the same, and within thirty-six hours from the time such fish or mass has been delivered to him, treat the same with sulphuric acid or other chemicals, approved by the director of said experiment station, in such quantity as to arrest decomposition: *provided, however*, that in lieu of such treatment such manufacturers may provide a means for consuming all smoke and vapors arising from such fertilizers during the process of manufacture.

SEC. 4011. Any person violating any provisions of the foregoing sections of this chapter shall be fined one hundred dollars for the first offense, and two hundred dollars for each subsequent violation.

SEC. 4012. This chapter shall not affect parties manufacturing, importing, or purchasing fertilizers for their own private use, and not to sell in this State.

SEC. 4013. The Director of the Connecticut Agricultural Experiment Station shall pay the analysis fees received by him into the treasury of the Station, and shall cause one or more analyses of each fertilizer to be made and published annually. Said director is hereby authorized. in person or by deputy, to take samples for analysis from any lot or package of manure or fertilizer which may be in the possession of any dealer.

SEC. 4014. The Director of the Connecticut Agricultural Experiment Station shall, from time to time, as bulletins of said Station may be issued, mail or cause to be mailed two copies, at least, of such bulletins to each post-office in the State.

OBSERVANCE OF THE FERTILIZER LAW.

Here follows an alphabetical list of the manufacturers who have paid analysis fees as required by the Fertilizer Law, and the names or brands of the fertilizers for which fees have been paid by them for the year ending May, 1898.

Firm.	*Brand of Fertilizer.*
Armour Fertilizer Works, Chicago, Ill.	Armour's Grain Grower.
	Bone, Blood and Potash.
	All Soluble.
	Ammoniated Bone with Potash.
Baker, H. J. & Bro., 93 William St., New York City.	Complete Tobacco Manure.
	"AA" Ammoniated Superphosphate.
	Harvest Home Fertilizer.
	Complete Potato Manure.
	Complete Manure for General Use.
	Vegetable, Vine and Potato Manure.
	Standard U. X. D. Fertilizer.
	Castor Pomace.
Berkshire Mills Co., Bridgeport, Conn.	Berkshire Complete Fertilizer.
	Ammoniated Bone Phosphate.
	Ground Bone.
Boardman, F. E., Little River, Conn.	Boardman's Complete Manure for Potatoes and Vegetables.
Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Stockbridge Special Tobacco Manure.
	" " Corn Manure.
	" Grass Top Dressing an Forage Crop Manure.
	" Potato and Vegetable Manure.
	Bowker's Potato Manure.
	" " Phosphate.
	" Hill and Drill Phosphate.
	" Farm and Garden or Ammoniated Bone Fertilizer.
	" Fish and Potash, Square Brand.
	" Tobacco Starter.
	" Sure Crop Phosphate.
	" Market Garden Manure.
	" Square Brand Bone and Potash.
	" Corn Phosphate.
	" Bone and Wood Ash Fertilizer.
	" Tobacco Ash Elements.
	Nitrate of Soda.
	Dissolved Bone Black.
	Muriate of Potash.
	Fresh Ground Bone.
	Fishermen's Brand Fish and Potash.
Bradley Fertilizer Co., 92 State St., Boston, Mass.	Bradley's Eclipse Phosphate.
	" High Grade Fertilizer.
	" New Method Fertilizer.

Firm.	*Brand of Fertilizer.*
Bradley Fertilizer Co., 92 State St., Boston, Mass.	Bradley's Original Coe's Superphosphate.
	" B. D. Sea Fowl Guano.
	" Fish and Potash, Triangle A. Brand.
	" Fish and Potash, Anchor Brand.
	" Circle Brand Ground Bone with Potash.
	" Fine Ground Bone.
	" Complete Manure for Corn and Grain
	" Complete Manure for Top Dressing Grass and Grain.
	" Complete Manure for Potatoes and Vegetables.
	" Potato Manure.
	" Superphosphate.
	" Corn Phosphate.
	" Potato Fertilizer.
Buckingham, C.. Southport, Conn.	XX Special Formula.
Burwell, E. E., New Haven, Conn.	Dried Blood and Meat.
	Dissolved Bone Black.
	Muriate of Potash.
	Nitrate of Soda
	Double Sulphate of Potash.
Clark's Cove Fertilizer Co., P. O. Box 1779, New York City.	Bay State Fertilizer.
	Bay State Fertilizer G. G.
	Great Planet A.
	King Philip.
	Potato and Tobacco Fertilizer.
	White Oak Bone.
	Potato Phosphate.
	Sweepstakes Potato Manure.
Cleveland Dryer Co., 92 State St., Boston, Mass.	Superphosphate.
	High Grade Complete Manure.
	Potato Phosphate.
	Fertilizer.
Clinton, Elbert, Clintonville, Conn.	Ground Bone.
Coe, E. Frank Co., 133–137 Front St., New York City.	E. Frank Coe's High Grade Ammoniated Bone Superphosphate.
	" " High Grade Potato Fertilizer.
	" " Ground Bone and Potash.
	" " Gold Brand Excelsior Guano
	" " Alkaline Bone Superphosphate.
Cooper's, Peter, Glue Factory, 14 Burling Slip, New York City.	Bone Dust.
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Crocker's Ammoniated Bone Superphosphate.

Firm.	*Brand of Fertilizer.*
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Crocker's Potato, Hop and Tobacco Phosphate.
	" Ammoniated Wheat and Corn Phosphate.
	" New Rival Ammoniated Superphosphate.
	" Practical Ammoniated Superphosphate.
	" General Crop Phosphate.
	" Universal Grain Grower.
	" New England Tobacco and Potato Grower.
	Ground Bone Meal.
	Pure Ground Bone.
	Vegetable Bone Superphosphate.
	Special Potato Manure.
Cumberland Bone-Phosphate Co., State St. and Merchants Row, Boston, Mass.	Superphosphate.
	Concentrated Phosphate.
	Potato Fertilizer.
	Guano.
Darling Fertilizer Co., The L B., Pawtucket, R. I.	Potato and Root Crop Manure.
	Animal Fertilizer.
	Garden and Lawn.
	Tobacco Grower.
	Pure Fine Bone.
	Animal G Brand.
Downs & Griffin, Derby, Conn.	Ground Bone.
Ellsworth, F., Hartford, Conn.	Shoemaker's Swift Sure Bone Meal.
	Shoemaker's Swift Sure Superphosphate.
Great Eastern Fertilizer Co., Rutland, Vt.	Northern Corn Special.
	General Fertilizer.
	Vegetable, Vine and Tobacco.
	Soluble Bone and Potash.
Hartford Fertilizer Co., Hartford, Conn.	Ground Bone.
Jefferds, John G., Worcester, Mass.	Ground Bone.
Kelsey, E. R., Branford, Conn.	Bone, Fish and Potash.
Lister's Agricultural Chemical Works, Newark, N. J.	Special Potato Fertilizer.
	Ammoniated Dissolved Bone.
	Success Phosphate.
	Standard Superphosphate of Lime.
Lowell Fertilizer Co, 44 N. Market St., Boston, Mass.	Swift's Lowell Bone Fertilizer.
	" " Complete Manure.
	" " Animal Fertilizer.
	" " Potato Phosphate.
	Tobacco Manure.
	Empire Brand.
	Fine Ground Bone.
	Dissolved Bone and Potash.

Firm.	*Brand of Fertilizer.*
Luce Bros., Niantic, Conn.	Luce Bros.' Pure Dry Ground Fish Guano.
	" " Giant's Neck Superphosphate.
	" " Bone Fish and Potash.
Ludlam, Frederick, 108 Water St., New York City.	Cecrops.
	Cereal Brand.
Lyman, Chas. E., Middlefield, Conn.	Corn Fertilizer.
Mapes Co., F. & P. G., 143 Liberty St., New York City.	Potato Manure.
	Tobacco Manure (Wrapper Brand).
	Economical Potato Manure.
	Corn Manure.
	Complete Manure, "A" Brand.
	Cereal Brand.
	Tobacco Starter.
	Fruit and Vine Manure.
	Vegetable Manure or Complete Manure for Light Soils.
	Grass and Grain Spring Top Dressing.
	Pure Fine Bone, Dissolved in Sulphuric Acid.
	Tobacco Ash Constituents.
	Seeding Down Manure.
Miles, Geo. W., Agent, Milford, Conn.	Ammoniated Bone Superphosphate.
	"Ceres" Brand.
	Fish Guano.
Miller, Geo. W., Middlefield, Conn.	Pure Ground Bone.
	Unexcelled Phosphate.
Milsom Rendering & Fertilizer Co., 963 William St., East Buffalo, N. Y.	Buffalo Fertilizer.
	Corn Fertilizer.
	Potato, Hop and Tobacco Phosphate.
	Vegetable Bone Fertilizer.
	Buffalo Guano.
	Cyclone Bone Meal.
	Erie King.
	Wheat, Oats and Barley Phosphate.
	Dissolved Bone and Potash.
	Bone Meal.
National Fertilizer Co., Bridgeport, Conn.	Chittenden's Complete Fertilizers.
	" Ammoniated Bone.
	" Fish and Potash.
	" Market Garden.
	" Potato Phosphate.
	" Fine Ground Bone.
Niagara Fertilizer Works, Buffalo, N. Y.	Niagara Wheat and Corn Producer.
	" Triumph.
	" Grain and Grass Grower.
	" Potato, Tobacco and Hop Fertilizer.
Nuhn, Frederick, Waterbury, Conn.	Self-Recommending Fertilizer.

Firm.	*Brand of Fertilizer.*
Olds & Whipple, Hartford, Conn.	O. & W. Special Phosphate.
Pacific Guano Co., P. O. Box 1368, Boston, Mass.	Soluble Pacific Guano.
	Special Potato Manure.
	Nobsque Guano.
	High Grade General Fertilizer.
	Potato and Tobacco Fertilizer.
	Grass and Grain Fertilizer.
	Fish and Potash.
	Fine Ground Bone.
Packer's Union Fertilizer Co., P. O. Box 1528, New York City.	Wheat, Oats and Clover.
	Universal Fertilizer.
	Animal Corn Fertilizer.
	Potato Manure.
	Gardener's Complete Manure.
Peck Bros., Northfield, Conn.	Pure Ground Bone.
Plumb & Winton Co., Bridgeport, Conn.	Ground Bone.
Preston Fertilizer Co., Greenpoint, L. I.	Ammoniated Bone Superphosphate.
Quinnipiac Co., 92 State St., Boston, Mass.	Fish and Potash, Crossed Fishes Brand.
	Climax Phosphate.
	Pequot Fish and Potash.
	Onion Manure.
	Phosphate.
	Potato Manure.
	Potato Phosphate.
	Market Garden Manure.
	Havana Tobacco Fertilizer.
	Grass Fertilizer.
	Corn Manure.
	Pure Bone Meal.
	Muriate of Potash.
	Sulphate of Potash.
	Nitrate of Soda.
	Sulphate of Ammonia.
	Dissolved Bone Black.
	Dry Ground Fish.
Read Fertilizer Co., Box 3121, New York City.	Read's Standard.
	Fish and Potash.
	Vegetable and Vine.
	High Grade Farmer's Friend.
Rogers & Hubbard Co., Middletown, Conn.	Hubbard's Pure Raw Knuckle Bone Flour.
	" Strictly Pure Fine Bone.
	" Oats and Top Dressing.
	" Soluble Potato Manure.
	" Soluble Tobacco Manure.
	" Grass and Grain Fertilizer.
	" Fruit Fertilizer.
	" All Crops All Soils.
	Fairchild's Corn Formula and General Crops.

Firm.	*Brand of Fertilizer.*
Rogers Mfg. Co., Rockfall, Conn.	High Grade Soluble Tobacco Manure.
	High Grade Soluble Potato and General Crop Manure.
	Complete Corn Manure.
	Complete Potato and Vegetable Fertilizer,
	High Grade Grass and Grain Fertilizer.
	High Grade Fertilizer for Oats and Top Dressing.
	Special High Grade Corn Fertilizer.
	Fish and Potash.
	Pure Fine Ground Bone.
Russia Cement Co., Gloucester, Mass.	Essex XXX. Fish and Potash.
	" High Grade Superphosphate.
	" Complete Manure for Corn, Grain and Grass.
	" Complete Manure for Potatoes, Roots and Vegetables.
	" Special for Tobacco.
Sanderson, L., New Haven, Conn.	Sanderson's Formula A.
	" Old Reliable Superphosphate.
	Nitrate of Soda.
	Muriate of Potash.
	Sulphate of Ammonia.
	Fine Ground Fish.
	Dissolved Bone Black.
	Blood, Bone and Meat.
	Fine Ground Bone.
	Plain Superphosphate.
	Sulphate of Potash.
Standard Fertilizer Co., Farlow Building, State St., Boston, Mass.	Fertilizer.
	Potato and Tobacco Fertilizer.
	Guano.
	Complete Manure.
Tucker Co., Henry F., Farlow Building, State St, Boston, Mass.	Tucker's Special Potato Fertilizer.
	" Imperial Bone Superphosphate.
Tygert Allen Fertilizer Co., 2 Chestnut St., Philadelphia, Pa.	Gold Edge Potato Guano.
	Star Bone Phosphate.
	Standard Bone Phosphate.
Walker, Stratman Co., Pittsburgh, Pa.	Potato Special.
	Smoky City.
	Four Fold.
Wheeler & Co., M. E., Rutland, Vt.	M. E. Wheeler & Co.'s High Grade Corn Fertilizer.
	" " " High Grade Potato Manure.
	" " " Superior Truck Fertilizer.
	" " " Havana Tobacco Grower.

Firm.	*Brand of Fertilizer.*
Wheeler & Co., M. E., Rutland, Vt.	M. E. Wheeler & Co.'s High Grade Fruit Fertilizer.
	" " " High Grade Grass and Oats.
	" " " High Grade Electrical Dissolved Bone.
	" " " High Grade Pure Ground Bone.
Wilcox Fertilizer Works, Mystic, Conn.	Potato, Onion and Tobacco Manure.
	Ammoniated Bone Phosphate.
	Complete Bone Superphosphate.
	High Grade Fish and Potash.
	Dry Ground Fish Guano.
Wilkinson & Co., P. O. Box 1807, New York City.	Economical Bone Fertilizer.
Williams & Clark Fertilizer Co., 27 William St., New York City.	Americus High Grade Special.
	" Fine Wrapper Tobacco.
	" Corn Phosphate.
	" Pure Bone Meal.
	" Potato Phosphate.
	" Ammoniated Bone Superphosphate.
	" Potato and Tobacco Fertilizer.
	Fish and Potash.
	Royal Bone Phosphate.
	Grass Manure.
Wilson, J. H., Norwalk, Conn.	Pure Bone Meal.
Woodruff & Sons, Orange, Conn.	Fertilizer.

SAMPLING AND COLLECTION OF FERTILIZERS.

During April, May and June, Mr. V. L. Churchill, the sampling agent of this Station, visited one hundred towns and villages of Connecticut, to draw samples of commercial fertilizers for analysis. These places were distributed as follows:—

Litchfield County	15
Hartford "	25
Tolland "	10
Windham "	7
New London "	9
Middlesex "	9
New Haven "	13
Fairfield "	12
	100

In these places 576 samples were taken, representing all but fourteen of the brands which have been entered for sale in this State.

The brands entered for sale in this State, which the sampling agent was unable to find on sale and of which no samples were received from the manufacturers, were the following:—

Bowker's Potato Manure.
 Potato Phosphate.
Bradley's High Grade Fertilizer.
Cleveland Dryer Co.'s Superphosphate.
 High Grade Complete.
 Potato Phosphate.
 Fertilizer.
Cumberland Bone Phosphate Co.'s Guano.
Darling Fertilizer Co.'s Tobacco Grower.
Pacific Guano Co.'s High Grade General Fertilizer.
 Potato and Tobacco Fertilizer.
Quinnipiac Co.'s Havana Tobacco Fertilizer.
Wheeler M. E., Superior Truck Fertilizer.
Woodruff & Son's Fertilizer.

It has not been possible, therefore, for the Station to make analyses of the above fertilizers.

When several samples of a single brand were drawn in different parts of the State the analysis was performed, not on any single sample, but on a mixture made of an equal weight of each of the several samples. Thus, it is believed, the average composition of the goods is more fairly represented than by the analysis of any single sample.

The Station agent is instructed in every case to open at least three packages of each brand for sampling, and if the number of packages is very large, to take a portion from every tenth one, by means of a sampling tube which withdraws a section or core through the entire length of the bag or barrel.

As a rule, the Station will not analyze samples taken—

1. From dealer's stock of less than one ton.
2. From stock which has lain over from last season.
3. From stock which evidently is improperly stored, as in bags lying on wet ground or exposed to the weather, etc.

The Station desires the coöperation of farmers, farmers' clubs and granges in calling attention to new brands of fertilizers, and in securing samples of all goods offered for sale. *All samples must be drawn in strict accordance with Station's Instructions for Sampling, and must also be properly certified*, if the Station analysis is desired. A copy of these instructions and blank certificates will be sent on application.

ANALYSES OF FERTILIZERS.

During the year, 548 samples of commercial fertilizers and manurial waste-products have been analyzed. A classified list of them is given on page 85.

On a few of these samples, analyses were made for private parties and charged for accordingly. A few samples also were analyzed at the request of other Experiment Stations in order to compare and test analytical methods. Results of the examination of all the samples, with these exceptions, are given in detail in the following pages. When the contrary is not stated, the samples were drawn by an agent of the Station.

Samples are analyzed as promptly as possible in the order in which they are received. As soon as an analysis is completed a copy of it is sent to the party who furnished the sample, and also to the manufacturer, in order that there may be opportunity for correction or protest, before the results are published.

The following "Explanations" are intended to embody the principles and data upon which the valuation of fertilizers is based, a knowledge of which is essential to a correct understanding of the analyses that are given on subsequent pages.

EXPLANATIONS CONCERNING THE ANALYSIS OF FERTILIZERS AND THE VALUATION OF THEIR ACTIVE INGREDIENTS.*

THE ELEMENTS OF FERTILIZERS.

The three chemical elements whose compounds chiefly give value, both commercial and agricultural, to fertilizers, are Nitrogen, Phosphorus and Potassium. The other elements found in fertilizers, viz: Sodium, Calcium, Magnesium, Iron, Silicon, Sulphur, Chlorine, Carbon, Hydrogen and Oxygen, which are necessary or advantageous to the growth of vegetation, are either so abundant in the soil or may be so cheaply supplied to crops, that they do not considerably affect either the value or cost of high-priced commercial fertilizers.

NITROGEN in fertilizers is, on the whole, the least abundant of their valuable elements, and is, therefore, their most costly ingredient.

Free Nitrogen is universally abundant, making up nearly four-fifths of the common air, and appears to be directly assimilable by various low vegetable organisms, and with aid of certain bacteria, by leguminous plants (the clovers, alfalfa, peas, beans, lentils, esparsette, lupins, vetches, lathyrus, peanut, yellow locust, honey locust, etc.), and by a few non-leguminous plants, carrying root nodules, viz: the Oleasters (*Eleagnus*), the Alders (*Alnus*), and a single family of coniferous trees (*Podocarpus*), but not at all, according to present evidence, by the cereals or other field and garden crops.

Organic Nitrogen is the nitrogen of animal and vegetable matters which is chemically united to carbon, hydrogen and oxygen. Some forms of organic nitrogen, as those of blood, flesh and seeds, are highly active as fertilizers; others, as found in leather and peat, are comparatively slow in their effect on vegetation, unless these matters are chemically disintegrated. Since organic nitrogen may often readily take the form of ammonia, it has been termed *potential ammonia.*

Ammonia (NH_3) *and Nitric Acid* (N_2O_6) are results of the chemical change of *organic nitrogen* in the soil and manure heap, and contain nitrogen in its most active forms. They occur in commerce—the former in sulphate of ammonia, the latter in nitrate of soda: 17 parts of ammonia, or 66 parts of pure sulphate of ammonia, contain 14 parts of nitrogen: 85 parts of pure nitrate of soda also contain 14 parts of nitrogen.

PHOSPHORUS is, next to nitrogen, the most costly ingredient of fertilizers, wherein it exists in the form of phosphates, usually those of calcium, iron and aluminum, or in case of "superphosphates," to some extent in the form of free phosphoric acid.

Water-soluble Phosphoric Acid is phosphoric acid (or a phosphate) that freely dissolves in water. It is the characteristic ingredient of superphosphates, in which it is produced by acting on "insoluble" (or

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* Prepared and revised by the Director.

"citrate soluble") phosphates, with diluted sulphuric acid. Once well incorporated with the soil, it gradually "reverts" and becomes insoluble, or very slightly soluble, in water.

Citrate-soluble Phosphoric Acid signifies the phosphoric acid (of various phosphates) that is freely taken up by a hot strong solution of neutral ammonium citrate, which solution is therefore used in analysis to determine its quantity. The designation *citrate-soluble* is synonymous with the less explicit terms *reverted*, *reduced* and *precipitated*, which all imply phosphoric acid that was once easily soluble in water, but from chemical change has become insoluble in that liquid.

Recent investigation tends to show that water-soluble and citrate-soluble phosphoric acid are on the whole about equally valuable as plant food, and of nearly equal commercial value. In some cases, indeed, the water-soluble gives better results on crops; in others, the "reverted" is superior. In most instances there is probably little to choose between them.

Insoluble Phosphoric Acid implies various phosphates insoluble both in water and in hot solution of neutral ammonium citrate. The phosphoric acid of Canadian "Apatite," of South Carolina and Florida "Rock Phosphate" and of similar dense mineral phosphates, as well as that of "bone ash" and "bone black," is mostly insoluble in this sense, and in the majority of cases gives no visible good results when these substances, in the usual ground state, are applied to crops. They contain, however, a small proportion of citrate-soluble phosphoric acid, and sometimes, when they are reduced to extremely fine dust (floats) or applied in large quantities, especially on "sour soils" or in conjunction with abundance of decaying vegetable matter (humus), they operate as efficient fertilizers.

Available Phosphoric Acid is an expression properly employed in general to signify phosphoric acid in any form, or phosphates of any kind that serve to nourish vegetation. In the soil, phosphoric acid and all phosphates, whatever their solubilities as defined in the foregoing paragraphs, are more or less freely and extensively available to growing plants. Great abundance of "insoluble" phosphoric acid may serve crops equally well with great solubility of a small supply, especially when the soil and the crop carry with them conditions highly favorable to the assimilation of plant food.

In Commercial Fertilizers, "available phosphoric acid" is frequently understood to be the sum total of the "water-soluble" and the "citrate-soluble," with the exclusion of the "insoluble."

The "insoluble phosphoric acid" in a commercial fertilizer costing $20 to $50 per ton, has very little or no value to the purchaser, because the quantity of it which can commonly go upon an acre of land has no perceptible effect upon the crop, and because its presence in the fertilizer excludes an equal percentage of more needful and much more valuable ingredients.

In Raw Bone the phosphoric acid (calcium phosphate) is nearly insoluble, because of the animal matter of the bones which envelops it; but when the animal matter decays in the soil, or when it is disintegrated by boiling or steaming, the phosphate mostly remains in an available form. The phosphoric acid of "Basic-Slag" and of "Grand Cayman's Phosphate" is in some soils as freely taken up by crops as water-soluble phosphoric acid, but in other soils is much less available than the latter.

Phosphoric acid in all the Station analyses is reckoned as "anhydrous phosphoric acid" (P_2O_5), also termed among chemists phosphoric anhydride, phosphoric oxide, and phosphorus pentoxide.

POTASSIUM is the constituent of fertilizers which ranks third in costliness. In plants, soils and fertilizers, it exists in the form of various salts, such as chloride (muriate), sulphate, carbonate, nitrate, silicate, etc. Potassium itself is scarcely known except as a chemical curiosity.

Potash signifies the substance known in chemistry as potassium oxide (K_2O), which is reckoned as the valuable fertilizing ingredient of "potashes" and "potash salts." In these it should be freely soluble in water and is most costly in the form of sulphate, and cheapest in the form of muriate (potassium chloride). In unleached ashes of wood and of cotton-seed hulls it exists mainly as potassium carbonate.

VALUATION OF FERTILIZERS.

The valuation of a fertilizer, as practised at this Station, consists in calculating the *retail Trade-value* or *cash-cost* (in raw material of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer.

Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates and similar articles, for which $30 to $50 per ton are paid, depend for their trade-value exclusively on the substances *nitrogen, phosphoric acid and potash*, which are comparatively costly and steady in price. The trade-value per pound of these ingedients is reckoned from the current market prices of the standard articles which furnish them to commerce.

The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the *Trade-value of the above named ingredients* a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use.

TRADE-VALUE OF FERTILIZER ELEMENTS, FOR 1897.*

The average trade-values or retail costs in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash in raw materials and chemicals, as found in New England, New York and New Jersey markets during 1896, were as follows:

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*Adopted at a conference of representatives of the Connecticut, Massachusetts, New Jersey and Rhode Island Stations held in March, 1897.

	Cts. per lb.
Nitrogen in ammonia salts	13½
nitrates	14
Organic nitrogen in dry and fine ground fish, meat and blood and in mixed fertilizers	14
in cotton seed meal	12
in fine* bone and tankage	13½
in medium* bone and tankage	11
in coarse* bone and tankage	8
Phosphoric acid, water-soluble	5½
citrate-soluble†	5
of fine* ground fish, bone and tankage	5
of medium* bone and tankage	4
of coarse* bone and tankage	2½
of cotton seed meal, castor pomace and wood ashes	4½
of mixed fertilizers (insoluble in ammonium citrate)	2
Potash as high-grade sulphate and in forms free from muriate (or chlorides)	5
as muriate	4½

The foregoing are, as nearly as can be estimated, the prices at which, during the six months preceding March last, the respective ingredients were retailed for cash, in our large markets, in those *raw materials* which are the regular source of supply. They also correspond to the average wholesale price for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to correspond fairly with the *average retail prices at the large markets, of standard raw materials, such as the following:*

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*In this Report "fine" as applied to bone and tankage, in contrast to "medium" and "coarse," signifies smaller than 1/50 inch; "medium," between 1/50 and 1/25 inch: "coarse," larger than 1/25 inch. From 1878 on for 10 years, we distinguished five grades of bone, as to fineness. In 1888 one, in 1897 two of the coarser grades had practically disappeared, from commercial ground bone. The three smaller grades remain unchanged in dimensions, as above stated, but the present "medium" was formerly "fine-medium" and the present "coarse" was for the first 10 years larger than ¼ inch, for the next 9 years included all larger than 1/12 inch, while now it signifies all larger than 1/25 inch, the former "coarse-medium" and "medium" having been successively merged in "coarse."

† Dissolved from 2 grams of the fertilizer, previously extracted with pure water, by 100 c.c. neutral solution of ammonium citrate, sp. gr. 1.09, in 30 minutes, at 65° C., with agitation once in five minutes. Commonly called "reverted" or "backgone" Phosphoric Acid.

Sulphate of Ammonia,
Nitrate of Soda,
Dried Blood,
Azotin,
Ammonite,
Muriate of Potash,
Sulphate of Potash,
Plain Superphosphates,
Dry Ground Fish,
Bones and Tankage,
Ground South Carolina Rock.

Valuation of Superphosphates, Special Manures and Mixed Fertilizers of High Grade.

The Organic Nitrogen in these classes of goods is reckoned at the price of nitrogen in raw materials of the best quality,* 14 cents.

Insoluble Phosphoric Acid is reckoned at 2 cents per pound. Potash is rated at 4¼ cents, if sufficient chlorine is present in the fertilizer to combine with it to make muriate. If there is more Potash present than will combine with the chlorine, then this excess of Potash is reckoned at 5 cents per pound.

In most cases the valuation of the ingredients in superphosphates and specials falls below the retail price of these goods. The difference between the two figures represents the manufacturer's charges for converting raw materials into manufactured articles and selling them. The charges are for grinding and mixing, bagging or barreling, storage and transportation, commission to agents and dealers, long credits, interest on investments, bad debts and, finally, profits.

The majority of the manufacturers agree that the average cost of mixing, bagging, handling and cartage ranges from $3.00 to $4.50 per ton.

In 1897 the average selling price of Ammoniated Superphosphates and Guanos was $30.44 per ton, the average valuation was $20.71 and the difference $9.73, an advance of 46.9 per cent. on the valuation and on the wholesale cost of the fertilizing elements in the raw materials.

* This concession gives the dishonest manufacturer the opportunity to defraud the consumer very easily and very seriously, by "working off" inferior or almost worthless leather, bat guano and similar materials which "analyze well," containing up to 8 or 9 per cent. of nitrogen, much or all of which may be quite inert. Since the Station has had no practicable means of determining with certainty the amount of worthless nitrogen or the quality of the nitrogen in a mixed fertilizer, and since the honest manufacturers (doubtless the greater number) use only "materials of the best quality," it would be unjust to them to assume that these fertilizers contain anything inferior. Farmers should satisfy themselves that they are dealing only with honest and with intelligent manufacturers. This can be done at little cost by such coöperation as Farmers' Clubs and Granges may practice, sending a competent and trusty agent to visit factories frequently and unexpectedly and take samples of raw materials. Honorable manufacturers will be glad to show all their raw materials and processes to their customers, especially if such inspection is insisted on as a preliminary to business. Coöperation may thus insure satisfactory quality of goods as well as reduced cost.

In case of special manures the average cost was $34.34, the average valuation $24.28 and the difference $10.06 or 41.4 per cent. advance on the valuation.

To obtain the Valuation of a Fertilizer we multiply the pounds per ton of nitrogen, etc., by the trade-value per pound. We thus get the values per ton of the several ingredients, and adding them together we obtain the total valuation per ton.

In case of *Ground Bone and Tankage*, the sample is sifted into the three grades just specified (see foot note, page 81), and we separately compute the nitrogen-value of each grade by multipling the pounds of nitrogen per ton by the per cent. of each grade, taking $\frac{1}{100}$th of that product, multiplying it by the trade-value per pound of nitrogen in that grade, and taking this final product as the result in cents. Summing up the separate values of each grade thus obtained, together with the values of each grade of phosphoric acid, similarly computed, the total is the Valuation of the sample of bone.

USES AND LIMITATIONS OF FERTILIZER VALUATION.

The uses of the "Valuation" are two-fold :

1. To show whether a given lot or brand of fertilizer is worth, as a commodity of trade, what it costs. If the selling price is not higher than the valuation, the purchaser may be tolerably sure that the price is reasonable. If the selling price is twenty to twenty-five per cent. higher than the valuation, it may still be a fair price ; but in proportion as the cost per ton exceeds the valuation there is reason to doubt the economy of its purchase.

2. Comparisons of the valuation and selling prices of a number of similar fertilizers will generally indicate fairly which is the best for the money.

But the valuation is not to be too literally construed, for in some cases analysis cannot discriminate positively between the active and the inert forms of nitrogen, while the mechanical condition of a fertilizer is an item whose influence cannot always be rightly expressed or appreciated.

For the above first named purpose of valuation, the trade-values of the fertilizing elements which are employed in the computations should be as exact as possible, and should be frequently corrected to follow the changes of the market.

For the second named use of valuation frequent changes of the trade-value are disadvantageous, because two fertilizers cannot be compared as to their relative money-worth when their valuations are deduced from different data.

Experience leads to the conclusion that the trade-values adopted at the beginning of the year should be adhered to as nearly as possible throughout the year, notice being taken of considerable changes in the market, in order that due allowance may be made therefor.

AGRICULTURAL VALUE OF FERTILIZERS.

The Agricultural Value of a fertilizer is measured by the benefits received from its use, and depends upon its fertilizing effect, or crop-producing power. As a broad, general rule, it is true that ground bone, superphosphates, fish scraps, dried blood, potash salts, etc., have a high agricultural value which is related to their trade-value, and to a degree determines the latter value. But the rule has many exceptions, and in particular instances the trade-value cannot always be expected to fix or even to indicate the agricultural value. Fertilizing effect depends largely upon soil, crop and weather, and as these vary from place to place, and from year to year, it cannot be foretold or estimated except by the results of past experience, and then only in a general and probable manner.

CLASSIFICATION OF FERTILIZERS ANALYZED.

RAW MATERIALS.

1. *Containing Nitrogen as the Chief Valuable Ingredient.*

	No. of Samples.
Nitrate of Soda	14
Sulphate of Ammonia	2
Dried Blood	4
Cotton Seed Meal	68
Linseed Meal	1
Castor Pomace	4
Horn and Hoof	1

2. *Containing Phosphoric Acid as the Chief Valuable Ingredient.*

Dissolved Bone Black	7
Acid Phosphate	7

3. *Containing Potash as the Chief Valuable Ingredient.*

High Grade Sulphate of Potash	7
Double Sulphate of Potash and Magnesia	6
Muriate of Potash	13
Kainit	5
Soap Boilers "Potash"	1

4. *Containing Nitrogen and Phosphoric Acid.*

Bone Manures	43
Tankage	23
Dried Fish	9

MIXED FERTILIZERS.

Bone and Potash	4
Nitrogenous Superphosphates and Guanos	119
Special Manures	108
Bone and Wood Ash Fertilizer	1
Home Mixtures	10

MISCELLANEOUS FERTILIZERS AND MANURES.

Cotton Hull Ashes	56
Cotton Hull and Hard Wood Ashes	1
Wood Ashes	22
Lime Kiln Ashes	1
Lime	5
Tobacco Stems	2
Garbage Fertilizer	3
Earth impregnated with Sewage	1
Total	548

DESCRIPTIONS AND ANALYSES OF FERTILIZERS.*

The samples referred to in the following pages, unless the contrary is stated, were drawn by an agent of the Station.

I. RAW MATERIALS CHIEFLY VALUABLE FOR NITROGEN.

NITRATE OF SODA OR SODIUM NITRATE.

Nitrate of Soda is mined in Chili and purified there before shipment. It contains about 16 per cent. of nitrogen, equivalent to 97 per cent. of pure sodium nitrate. The usual guarantee is "96 per cent." of sodium nitrate, equivalent to 15.8 per cent. of nitrogen.

In rare cases cargoes have been found to contain sodium perchlorate which, even in small amount, is very injurious to vegetation.

6703. Sold by S. D. Woodruff & Sons, Orange.

8059. Sold and sampled by E. E. Burwell, New Haven.

6726. Sold by L. Sanderson, New Haven.

8342. Sold by A. G. Smith, Wethersfield, agent of the Bowker Fertilizer Co. Sampled and sent by James P. O'Connor, Wethersfield.

8058. Sold by L. Sanderson, New Haven. Sampled and sent by W. L. & S. T. Merwin, Milford.

8176. Sold by Bowker Fertilizer Co., Boston, Mass. Sampled from stock of W. O. Goodsell, Bristol.

8217. Sold by Wilcox Fertilizer Works, Mystic.

8124. Sold by M. E. Wheeler & Co., Rutland, Vt. Sampled from stock of W. C. Pease, Somers.

6765. Sold by Mapes' Branch, Hartford.

6725. Sold by the Quinnipiac Co., Boston, Mass. Sampled by F. O. & O. Ives, West Cheshire.

6694. Sold by L. Sanderson, New Haven. Sampled and sent by W. L. & S. T. Merwin, Milford.

8122. Sold by Darling Fertilizer Co., Pawtucket, R. I. Sampled from stock of W. W. Cooper, Suffield.

6769. Sold by Quinnipiac Co., through Olds & Whipple, Hartford.

The percentage of nitrogen in these samples ranged from 15.02, a rather low figure, to 16.27.

The cost of nitrogen per pound in twelve samples of nitrate of soda has ranged from 13.7 to 15.6 cents, an average of 14.6 cents.

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* This chapter, pp. 86 to 157, has been prepared for publication by Dr. Jenkins. The analyses of fertilizers have all been made by Messrs. Winton, Ogden and Mitchell, chemists of the Station, with the assistance of Mr. Lange.

ANALYSES OF NITRATE OF SODA.

	6703	8059	6726	8342	8058	8176	8217	8121	6765	6725	6694	8122	6769
Moisture	1.63	1.07	1.31	4.18	3.06	3.11	2.81	1.76	.64	1.72	4.46	2.03	1.80
Insoluble in Water	.17	.24	.41	.86	.34	.86	.19	.18	.21	.12	.31	.29	.23
Common Salt	.76	.76	.81	.86	.96	.88	.39	.37	.35	.68	1.01	.76	.68
Sodium Sulphate	.33	.42	.34	1.82	1.53	1.00	.26	.23	.22	.26	3.14	.27	.32
Sodium Nitrate	97.11	97.51	97.13	92.28	94.11	94.20	96.35	97.46	98.58	97.22	91.08	96.65	96.97
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Equivalent Nitrogen	16.02	16.08	16.02	15.23	15.52	15.54	16.09	16.08	16.27	16.04	15.02	15.94	16.00
Cost per ton		$44.00	45.00	43.00	45.00	45.00	47.00	47.00	48.00	47.50	45.00	48.00	50.00
Nitrogen cost cents per pound,		**13.7**	**14.0**	**14.1**	**14.5**	**14.5**	**14.6**	**14.6**	**14.8**	**14.8**	**14.9**	**15.1**	**15.6**

SULPHATE OF AMMONIA, OR AMMONIUM SULPHATE.

This article, now made on a large scale as a by-product of gas works and coke ovens, usually contains over 20 per cent. of nitrogen, the equivalent of 94–97 per cent. of ammonium sulphate. The rest is chiefly moisture. The usual guarantee is 25 per cent. of ammonia, which is equivalent to 20.6 per cent. of nitrogen.

6730. Sold by L. Sanderson, New Haven.

6751. Sold for the Quinnipiac Co., Boston, by Olds & Whipple, Hartford.

ANALYSES.

	6730	6751
Nitrogen	20.88	20.84
Equivalent Ammonia	25.26	25.11
Cost per ton	$60.00	60.00
Nitrogen costs cents per pound	14.4	14.4

Sulphate of ammonia, which of late years has been too costly to warrant its use as a fertilizer, is not now more expensive than nitrate of soda as a source of nitrogen, and if the price falls still lower, will no doubt come into use again among farmers who buy fertilizer chemicals.

DRIED BLOOD.

This consists of slaughter-house blood which has been dried by superheated steam or hot air. It is a finely pulverized, nearly odorless substance, red or nearly black in color, and rich in nitrogen that is quickly available to vegetation.

6507. Sold by John W. Daly, Meriden. Sampled and sent by L. H. Francis, Meriden.

8281. Sold by the Pacific Guano Co. Sampled and sent by Geo. H. Bartlett, No. Guilford.

8002. Sampled and sent by Geo. P. Docker, Fairfield. Bought for poultry food, but its use was followed by the death of very many fowls.

ANALYSES.

	6507	8281	8002
Nitrogen	9.00	13.38	10.24
Phosphoric Acid	3.88	....	.93
Cost per ton	$27.00	30.00	....
Nitrogen costs cents per pound*	14.1	11.2	....

* Allowing 2 cents per pound for the phosphoric acid.

COTTON SEED MEAL.

This material is of two kinds, which are known in trade respectively as undecorticated and decorticated. In their manufacture cotton seed is first ginned to remove most of the fiber, then passed through a "linter" to take off the short fiber or lint remaining, then through machines which break and separate the hulls. The hulled seed is ground and the oil expressed. The ground cake from the presses is used as a cattle food and fertilizer. The hulls are burned for fuel in the oil factory, and the ashes, which contain from 20 to 30 per cent. of potash, are also used as a fertilizer. In case of undecorticated meal the hulls and the ground press-cake are mixed together.

Decorticated Cotton Seed Meal.

Sixty-five samples of decorticated cotton seed meal have been examined with the results given in the table on pages 90 and 91.

Nitrogen has been determined in all these samples.

In 16 samples phosphoric acid and potash were also determined. The former ranges from 2.69 to 3.44 per cent., the latter from 1.64 to 2.00 per cent. It having been impracticable to determine phosphoric acid and potash in the other 49 samples, the average results found in the 16 analyses are placed in the tables as expressing with sufficient accuracy the percentages of these ingredients in the 49 samples.

The average cost of cotton seed meal has been about $22.00 per ton. The percentage of nitrogen has ranged higher than in previous years, viz., from 8.02 to 6.92, and has averaged 7.4. The average cost per pound of nitrogen has been 11.6 cents. Decorticated cotton seed meal continues to be the cheapest source of quickly available organic nitrogen. Its use is becoming more general in the tobacco-growing sections of this State, but it deserves the attention of farmers generally.

Undecorticated Cotton Seed Meal.

6753. Sent by P. K. Hoadley, North Guilford, from stock bought of R. G. Davis, New Haven, under the name of "Tankage Cotton Seed Meal."

This was a dark-colored meal in which black cotton hulls were readily recognized. The analysis is given on page 92.

ANALYSES OF DECORTICATED COTTON SEED MEAL.

Station No.	Dealer.	Sampled by	Nitrogen.	Phosphoric Acid.	Potash.	Cost per Ton.	Nitrogen costs cents per pound.
8143	Nathan Tufts, Boston, Mass.	Horatio Lothrop, Suffield	7.50	3.15	1.90	$18.60*	9.2
8038	R. H. Ensign, Simsbury	A. M. Shepard, W. Simsbury	7.57	3.15	1.90	20.50	10.4
6543	Daniels Mills Co., Hartford	E. S. Seymour, Windsor Locks	7.48	3.17	1.93	20.50*	10.5
6571	Daniels Mills Co, Hartford	L. H. Brewer, Hockanum	7.66	3.15	1.90	21.25	10.8
6714		C. A. Pease, 130 Main St., Hartford	8.02	3.15	1.90	22.00	10.8
6544	Ernest N. Austin, Suffield	H. H. Austin, Suffield	7.64	3.44	2.00	21.75	10.9
6649	W. F. Fletcher, Southwick, Mass.	John B. Cannon, West Suffield, Conn.	7.65	3.15	1.90	21.50	10.9
8127	J. M. Newberry, East Windsor Hill	Wm. Phelps, Warehouse Point	7.45	3.15	1.90	21.00*	10.9
8037	R. H. Ensign, Simsbury	A. M. Shepard, West Simsbury	7.18	3.15	1.90	20.50	11.0
8049	W. W. Cooper, Suffield	L. F. Woodworth, Thompsonville	7.82	3.15	1.90	22.00	11.0
6541	Ernest N. Austin, Suffield	W. H. Prout, Suffield	7.59	3.34	1.97	21.75	11.0
6551	Suffield Grange	Chas. A. Birge, Suffield	7.69	3.29	1.92	21.75	11.0
6552	F. S. Bidwell, Windsor Locks	Chas. A. Birge, Suffield	7.60	3.13	1.85	21.50	11.1
6569	Arthur Sikes, Suffield	G. A. Douglass, Thompsonville	7.57	3.15	1.90	21.50	11.1
6663	R. H. Ensign, Simsbury	Henry N. Goddard, Simsbury	7.36	3.15	1.90	21.25	11.2
6566	W. W. Cooper, Suffield	H. H. Austin, Suffield	7.56	3.15	1.90	21.75	11.2
8241	E. F. Miller, Ellington	M. E. Thompson, Ellington	7.50	3.15	1.90	21.50	11.2
6717	Ernest N. Austin, Suffield	Wm. Right, Suffield	7.42	3.15	1.90	21.50	11.3
6682	James Perkins, Suffield	Michael Doughney, Windsor Locks	7.41	3.15	1.90	21.50	11.3
6719	Ernest N. Austin, Suffield	Arthur Pomroy, Suffield	7.40	3.15	1.90	21.50	11.3
8162	Daniels Mills Co., Hartford		7.65	3.15	1.90	22.00	11.3
8184	H. K. Brainard, Thompsonville		7.44	3.15	1.90	21.50	11.3
6547	Arkansas Cotton Oil Co., Helena, Ark.	C. M. Owen, West Suffield	7.30	3.34	1.91	21.50	11.4
6546	Arkansas Cotton Oil Co., Helena, Ark.	C. M. Owen, West Suffield	7.57	2.69	1.76	21.50	11.4
6550	James Perkins, Suffield	Chas. A. Birge, Suffield	7.84	3.07	1.86	22.50	11.4
8163	Daniels Mills Co., Hartford		7.13	3.15	1.90	21.00	11.4
6655	F. L. Worthy & Co., Mittineague, Mass.	D. L. Brockett, Suffield	7.26	3.15	1.90	21.50	11.5
6542	James E. Perkins, Suffield	W. C. Smith, Suffield	7.74	3.10	1.86	22.50	11.5
6567	Ernest N. Austin, Suffield	H. H. Austin, Suffield	7.42	3.15	1.90	21.75	11.5
8051	Daniels Mills Co. Hartford	W. H. Harvey, Windsor	7.22	3.15	1.90	21.50	11.6
6664	David L. Brockett, Suffield	Chas. T. Remington, Thompsonville	7.44	3.15	1.90	22.00	11.6
6691	C. H. Dexter & Son, Windsor Locks	Thos. Fitzgerald, Windsor Locks	7.66	3.15	1.90	22.50	11.6
6553	James Perkins, Suffield	Chas. A. Birge, Suffield	7.75	2.85	1.64	22.25	11.6

* Car lot.

ANALYSES OF DECORTICATED COTTON SEED MEAL—*Continued.*

Station No.	Dealer.	Sampled by	Nitrogen.	Phosphoric Acid.	Potash.	Cost per Ton.	Nitrogen costs cents per pound.
6685	Loomis Bros., Granby	S. M. Griffin, Tariffville	7.47	3.15	1.90	$22 00	11.6
6799	W. F. Fletcher, Southwick, Mass	Alfred H. Griffin, Granby	7.50	3.15	1.90	22.25	11.7
8050	Chas. W. Atwood	G. B. Porter, Waterbury	7.35	3.15	1.90	22.00	11.7
8139	A. Pouleur, Windsor Locks		7.14	3.15	1.90	21.50	11.7
6712	W. W. Cooper, Suffield	E. J. Sheldon, West Suffield	7.34	3.15	1 90	22.00	11.8
6795	C. H. Dexter & Son, Windsor Locks	Frank G Naughton, Warehouse Point	7.19	3.15	1.90	21.75	11.8
8135	W. F. Fletcher, Southwick, Mass.	J. B. Cannon, West Suffield	7.29	3.15	1.90	22.00	11.8
8277	C. M. Cox & Co., Boston, Mass.	C. J. Dewey, Buckland	7.08	3.15	1.90	21.50	11.8
8032	—— Dexter, Windsor Locks	J. A. DuBon, Poquonock	7.40	3.15	1.90	22.25	11.9
6558	A. D. Bridge, Hazardville	W. H. Martin, Scitico	7.34	3.38	1.96	22.50	11.9
6568	Olds & Whipple, Hartford	Jos. Frohliuger, Jr., Suffield	7.44	3.15	1.90	22.50	11.9
6662		Henry N. Goddard, Simsbury	6.96	3.15	1.90	21.25	11.9
6538	Olds & Whipple. Hartford	John DuBon, Poquonock	7.57	3.22	1.92	23.00	12.0
6718	E. Danielson, Suffield	Howard A. Button, Suffield	7.22	3.15	1.90	22.00	12.0
6672	Ernest N. Austin, Suffield	H. H. Austin, Suffield	7.01	3.15	1.90	21.50	12.0
6671	Ernest N. Austin, Suffield	H. H. Austin, Suffield	6.92	3.15	1.90	21.50	12.1
6674	Olds & Whipple, Hartford	T. P. Kinney, Windsor	7.51	3.15	1.90	23.00	12.1
6740	R. A. Parker, Warehouse Point	E F. Thompson, Warehouse Point	7.53	3.15	1.90	23.00	12.1
6526	Daniels Mills Co., Hartford	Jas. E. Perkins, Suffield	7.42	3.02	1.85	22.50	12.1
8191		Peter Whalen, South Windsor	6.92	3 15	1.90	21.50	12.1
6557	A. D. Bridge. Hazardville	W. H. Martin, Scitico	7.30	3.22	1.93	22.50	12.1
8136	Olds & Whipple, Hartford		7.36	3.15	1.90	22.50	12.1
8140	C. H. Dexter & Son, Windsor Locks	C. D. Cannon, Windsor Locks	7.26	3.15	1.90	22.50	12.2
8111	Daniels Mills Co., Hartford	Gust. O. Berntson, Bloomfield	7.05	3.15	1.90	22.00	12.2
6788	Olds & Whipple, Hartford	Clark Bros., Poquonock	7.46	3.15	1.90	23.00	12.2
8113	W. W. Cooper, Suffield		7.08	3.15	1.90	22.00	12.2
6539	Olds & Whipple, Hartford	John DuBon, Poquonock	7.49	2.99	1.91	23.00	12.3
6796	Francis Granger, East Granby, Conn.	Virgil E. Viets, Copper Hill	7.44	3.15	1.90	23.00	12.3
8036	Olds & Whipple, Hartford	E. J. Wells, East Windsor Hill	7.36	3.15	1.90	23.00	12.4
6556	A. D. Bridge, Hazardville	W. H. Martin, Scitico	7.18	3.21	1.86	22.50	12.4
8137	Olds & Whipple, Hartford		7.38	3.15	1.90	23.50	12.7
8345		W. W. Loomis, Windsor	7.11	3.15	1.90	23.00	12.8

ANALYSIS OF UNDECORTICATED COTTON SEED MEAL.

	6753
Nitrogen	4.48
Phosphoric Acid	1.88
Potash	1.58
Cost per ton	$18.00
Nitrogen costs cents per pound	16.4

While the average cost of nitrogen in decorticated cotton seed meal was 11.6 cents per pound, the nitrogen of undecorticated meal, which is somewhat less valuable *agriculturally* than the other, cost 16.4 cents per pound.

CASTOR POMACE.

This is the ground residue of castor beans from which castor oil has been extracted. The nitrogen which it contains is quickly available to plants, but the pomace is extremely poisonous to animals, which often eat it greedily when the opportunity offers.

8109. Sold by H. J. Baker & Bro., New York City. Sampled from stock of Carlos Bradley, Ellington.

8123. Sold by Bowker Fertilizer Co., Boston, Mass. Sampled from stock of H. K. Brainard, Thompsonville.

ANALYSES.

	8109	8123
Nitrogen	4.51	4.02
Phosphoric Acid	1.45	1.25
Potash	1.00	.89
Cost per ton	$19.00	19.00
Nitrogen costs cents per pound*	**18.5**	**21.1**

This material, which has been a favorite fertilizer among tobacco growers, is the most expensive form of organic nitrogen in our market.

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* Reckoning phosphoric acid and potash at 4½ and 5 cents per pound respectively.

II. RAW MATERIALS OF HIGH GRADE CONTAINING PHOSPHORIC ACID AS THE CHIEF VALUABLE INGREDIENT.

DISSOLVED BONE BLACK.

Bone Black, made by subjecting bone to a red heat without access of air, is used in sugar refineries to decolorize sugar solutions. The waste bone black, dried and treated with oil of vitriol, makes a "superphosphate" of high grade which does not cake together on standing, but remains as a fine powder suitable for application to the land.

8236. Sold by Bowker Fertilizer Co., Boston, Mass. Stock of A. L. Hitchcock, Plainville.

8062. Sold and sampled by E. E. Burwell, New Haven.

8282. Sold by Pacific Guano Co., Boston, Mass. Sampled by George H. Bartlett, North Guilford.

6768. Sold by the Quinnipiac Co., Boston, Mass. Stock of Olds & Whipple, Hartford.

6696. Sold by L. Sanderson, New Haven. Sent by W. L. & S. T. Merwin, Milford.

6733. Sold by L. Sanderson, New Haven.

8211. Sold by Wilcox Fertilizer Works, Mystic.

ANALYSES OF DISSOLVED BONE BLACK.

	8236	8062	8282	6768	6696	6733	8211
Soluble Phosphoric Acid	10.66	8.17	14.67	11.89	16.83	17.01	16.17
Reverted Phosphoric Acid	5.21	8.96	2.20	6.32	.19	.23	.05
Insoluble Phosphoric Acid	1.02	1.13	.18	2.28	.05	.02	...
Total	16.89	18.26	27.05	20.49	17.07	17.26	16.22
Cost per ton	$19.50	23.00	20.00	24.00	23.00	23.00	22.00
"Available" Phosphoric Acid costs cents per pound	6.1	6.7	5.9	6.3	6.7	6.7	6.8

DISSOLVED ROCK PHOSPHATE OR ACID ROCK.

This material, made by treating various mineral phosphates with oil of vitriol, is the most common source of the phosphoric acid of factory-mixed fertilizers.

6565. Sold by Berkshire Mills, Bridgeport, to S. E. Curtis, Stratford.

6783. Sold by Berkshire Mills, Bridgeport, to J. Norris Barnes, Yalesville.

6732. Stock of L. Sanderson, New Haven.

6724. "Soluble Dissolved Bone Acid Phosphate." Sold by Quinnipiac Co., N. Y. Sampled and sent by F. O. Ives, West Cheshire.

8219. "Electrical Dissolved Bone." Made by M. E. Wheeler & Co., Rutland, Vt. Stock of C. I. Harvey & Son, Middletown. This is not dissolved bone.

6700. Stock of S. D. Woodruff & Sons, Orange.

ANALYSES OF DISSOLVED ROCK PHOSPHATE.

	6565	6783	6732	6724	8219	6700
Soluble Phosphoric Acid	8.62	12.19	13.14	11.84	5.73	11.04
Reverted Phosphoric Acid....	2.46	1.90	3.51	3.27	7.80	2.78
Insoluble Phosphoric Acid ...	.88	1.10	.66	.83	.95	1.03
Total................	11.96	15.19	17.31	15.94	14.48	14.85
Cost per ton................	11.00	....	15.00	16.00	22.00	....
"Available" Phosphoric Acid costs cents per pound..................	4.8	....	4.4	5.2	8.0	....

"Available" phosphoric acid almost invariably costs more in form of dissolved bone black than in form of dissolved rock phosphate. The latter forms the basis of most of the nitrogenous superphosphates in market and the soluble phosphoric acid in the two forms is equally available to plants.

In the samples whose analyses appear in the table the cost of available phosphoric acid from dissolved bone black has been about 6¼ cents per pound, from dissolved rock phosphate about 5 cents per pound.

III. RAW MATERIALS OF HIGH GRADE CONTAINING POTASH.

HIGH GRADE SULPHATE OF POTASH.

This chemical should contain over 90 per cent. of pure potassium sulphate (sulphate of potash) or about fifty per cent. of potassium oxide, the same quantity as is supplied by muriate, and should be nearly free from chlorine.

8144. Sold by H. J. Baker & Bro., New York City. Sampled by H. H. Austin, Suffield, from stock of E. N. Austin.

6720. Sold by F. S. Bidwell, Windsor Locks. Sampled by S. D. Phelps, Suffield.

6750. Sold by the Quinnipiac Co., Boston. Sampled from stock of Olds & Whipple, Hartford.

6721. Sold by the Quinnipiac Co., Boston. Sampled by F. O. Ives, West Cheshire.

6729. Sold by L. Sanderson, New Haven.

8121. Sold by M. L. Shoemaker & Co., Phila. Sampled from stock of W. W. Cooper, Suffield.

8218. Sold by the Wilcox Fertilizer Works, Mystic, Conn.

DOUBLE SULPHATE OF POTASH AND MAGNESIA.

This material is usually sold as "sulphate of potash" or "manure salt," on a guarantee of "48–50 per cent. sulphate," which is equivalent to 25.9–27.0 per cent. of potassium oxide. Besides some 46–50 per cent. of potassium sulphate, it contains over 30 per cent. of magnesium sulphate, chlorine equivalent to 3 per cent. of common salt, a little sodium and calcium sulphates, with varying quantities of moisture.

8053. Sold by H. J. Baker & Bro., New York City. Bought of the Apothecaries Hall Co. by G. B. Porter, Waterbury, and sampled and sent by him.

This sample represents goods bought by Mr. Porter as high grade sulphate of potash, for $47 per ton. On receiving the Station analysis, Mr. Porter called the attention of the seller to the mistake, which was rectified by changing the charge per ton to $26.00.

8060. Sold by E. E. Burwell, New Haven. Sampled by E. E. Burwell, New Haven.

6766. Sold by Mapes' Branch, Hartford.

6752. Sold by the Quinnipiac Co., Boston. Stock of Olds & Whipple, Hartford.

6731. Sold by L. Sanderson, New Haven.

8159. Sold by the Read Fertilizer Co., New York City. Sampled by James Burr, Monroe.

This material was billed to Mr. Burr as muriate of potash, through a mistake in shipping the goods. The error was discovered by the analysis of the goods and promptly rectified by the Read Fertilizer Co.

ANALYSES OF THE POTASH SALTS. (☞)

HIGH GRADE SULPHATE OF POTASH.

	8144	**6720**	**6750**	**6721**	**6729**	**8121**	**8218**
Equivalent Sulphate of Potash*	90.52	90.24	90.50	89.24	91.83	89.82	92.46
Potash*	48.93	48.78	48.92	48.24	49.64	48.55	49.98
Cost per ton*	$46.00	48.00	54.00	52.00	47.50	50.00	54.00
Potash costs cents per pound*	4.7	4.9	5.5	5.4	4.8	5.1	5.4

MURIATE OF POTASH.

	8052	**6564**	**8248**	**8061**
Potash*	51.01	51.25	51.15	48.89
Equivalent Muriate of Potash*	80.60	80.98	80.82	77.25
Cost per ton*	$45.00	40.00	41.00	42.00
Potash costs cents per pound*	4.4	3.9	4.0	4.3

MURIATE OF POTASH.

Commercial muriate of potash contains about 80 per cent. of muriate of potash (potassium chloride), 15 per cent. or more of common salt (sodium chloride), and 4 per cent. or more of water.

It is generally retailed on a guarantee of 80 per cent. muriate, which is equivalent to 50.5 per cent. of potassium oxide.

8052. Sold by H. J. Baker & Bro., New York City. Sampled by G. B. Porter, Waterbury.

6564. Sold by Berkshire Mills, Bridgeport. Sent by S. E. Curtis, Stratford.

8248. Sold by Bowker Fertilizer Co., Boston, Mass. Sampled from stock of Daniels Bros., Middletown.

8061. Sold and sampled by E. E. Burwell, New Haven.

8280. Sold and sampled by E. E. Burwell, New Haven.

8125. Sold by Darling Fertilizer Co., Pawtucket, R. I. Sampled from stock of W. W. Cooper, Suffield.

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* Refers also to analyses on opposite page, 97.

6767. Sold by Mapes' F. & P. G. Co., Hartford Branch.

6723. Sold by the Quinnipiac Co., Boston. Sampled by F. O. Ives, West Cheshire.

6695. Sold by L. Sanderson, New Haven. Sent by W. L. & S. T. Merwin, Milford.

6728. Sold by L. Sanderson, New Haven.

6779. Sold by L. Sanderson, New Haven. Sent by J. Norris Barnes, Yalesville.

6704. Sampled from stock of S. D. Woodruff & Sons, Orange.

DESCRIBED ON PAGES 95 TO 98.

DOUBLE SULPHATE OF POTASH.						KAINIT.			
8053	**8060**	**6766**	**6752**	**6731**	**8159**	**8158**	**8126**	**8249**	**8250**
52.26	54.91	44 84	47.73	43.01	58.60	23.81	23.16	22.66	21.33
28.25	29.68	24.24	25.80	23.25	31.70	12.87	12.52	12.25	11.53
....	28.00	29.00	32.00	28.00	....	14.00	12.00	12.00	12.00
....	4.7	6.0	6.0	6.0	....	5.4	4.8	4.9	5.2

MURIATE OF POTASH.

8280	**8125**	**6767**	**6723**	**6695**	**6728**	**6779**	**6704**
53.59	51.12	52.63	49.79	52 22	52.73	48.98	51.20
84.67	80.77	83 16	78.67	82.51	83.31	77.39	80.92
42.00	45.00	43.00	45.00	42.50	42.50	....	....
3.9	4.4	4.1	4.5	4.1	4.0	....	....

KAINIT.

Kainit is less uniform in composition than the other potash salts. It contains from 11 to 15 per cent. of potash, more than that quantity of soda, and rather less magnesia. These "bases" are combined with chlorine and sulphuric acid. Unless "calcined" it contains more water than occurs in sulphate or in muriate of potash. It is usually sold on a guarantee of 12 to 15 per cent. of potash, or 23 to 25 per cent. "sulphate of potash." It is not properly called or claimed to be a sulphate of potash, since it contains more than enough chlorine to combine with all the potash present, and there are sound reasons for believing that its potash exists largely as muriate and to a much less extent as sulphate. Its action and effects are unquestionably those of a muriate rather than of a sulphate.

8158. Sold by the Read Fertilizer Co., New York City. Sampled and sent by James Burr, Monroe.

8249 and **8250.** Samples from the same invoice. Sold by the Williams and Clark Fertilizer Co., New York City. Sampled from stock of B. F. Pinney, Ellington. By M. E. Thompson.

8126. Sold by Williams and Clark Fertilizer Co., New York City. Sampled from stock of E. F. Miller, Ellington.

The retail cash cost of potash in cents per pound in the various potash salts whose analyses are given in the table, has been as follows:

	Highest.	Lowest.	Average.
In high grade sulphate	5.5	4.7	5.1
In double sulphate	6.0	4.7	5.7
In muriate	4.5	3.9	4.2
In kainit	5.4	4.8	5.1

SOAP-BOILERS' "POTASH."

This material, it is stated, is brought from Canada in hogsheads, and is prepared by leaching wood-ashes with water (often in presence of slacked lime) and boiling down the lye until it solidifies on cooling.

A sample, No. **6699**, was sent by Mr. E. S. Clark, of Hartford, who has used it, dissolved in water, as a fertilizer for tobacco land, and also for "spotting" tobacco in the field.

This "potash" comes in brown, hard, and tough lumps, which on exposure to air become wet, pasty, and finally liquify by absorbing moisture. It is very caustic and soapy to the touch, and has a bitter, "alkaline" taste.

ANALYSIS.

	6699
Matters insoluble in water	2.95
Potash (potassium oxide)	69.29
Soda (sodium oxide)	1.40
Sulphuric acid (sulphur trioxide)	8.18
Chlorine	1.16
Water, carbonic acid and other matters, by difference	17.02
	100.00

The analysis shows that the sample contained about 3 per cent. of insoluble matters, 2 per cent. of common salt, 16¾ per cent. of sulphate of potash, and about 60¼ per cent. of hydrate and carbonate of potash.

IV. RAW MATERIALS CONTAINING NITROGEN AND PHOSPHORIC ACID.

BONE MANURES.

The terms "Bone Dust," "Ground Bone," "Bone Meal," and "Bone" applied to fertilizers, sometimes signify material made from dry, clean and pure bones; in other cases these terms refer to the result of crushing fresh or moist bones which have been thrown out either raw or after cooking, with more or less meat, tendon, and grease and—if taken from garbage or ash heaps—with ashes or soil adhering; again they denote mixtures of bone, blood, meat and other slaughter-house refuse which have been cooked in steam tanks to recover grease, and are then dried and sometimes sold as "tankage;" or finally, they apply to bone from which a large share of the nitrogenous substance has been extracted in the glue manufacture. When they are in the same state of mechanical subdivision the nitrogen of all these varieties of bone probably has about the same fertilizing value.

The method adopted for the valuation of bone manures, which takes account of their mechanical condition as well as chemical composition, is explained on page 83.

1. *Bone Manures Sampled by Station Agents.*

In the following table are given analyses of twenty-eight samples of bone drawn by the Station agents. See pages 100 and 101.

The average cost per ton has been $29.61; the average valuation $28.03, showing that the Station schedule of valuations for bone has been scarcely lower than is justified by the average selling price of bone.

Bradley's Fine Ground Bone.

6791. Sample drawn from stock of S. A. Billings, Meriden. The analysis is given on page 102. The manufacturer, the Bradley Fertilizer Co. of Boston, claimed that the analysis did not fairly represent the quality of the brand, which contained more nitrogen. Another sample, **8802,** was therefore drawn from the stock of three dealers and analyzed with the results given on page 101.

BONE MANURES. SAMPLED BY (☞)

Station No.	Name or Brand.	Manufacturer.
6675	Bone Meal.	Hartford Fertilizer Co., Hartford.
8028	Ground Bone.	National Fertilizer Co., Bridgeport.
8178	Hubbard's Pure Raw Knuckle Bone Flour.	Rogers & Hubbard Co., Middletown.
6737	Ground Bone.	Berkshire Mills, Bridgeport.
6758	Bone Meal No. 1.	Quinnipiac Co., Boston, Mass.
6754	Hubbard's Strictly Pure Fine Bone.	Rogers & Hubbard Co., Middletown.
8048	Fresh Ground Bone.	Bowker Fertilizer Co., Boston, Mass.
8031	Ground Bone.	Downs & Griffin, Derby.
6755	Hubbard's Pure Raw Knuckle Bone Flour.	Rogers & Hubbard Co., Middletown.
8043	Self-Recommending Fertilizer.	F. Nuhn, Waterbury.
8042	Fine Ground Bone.	Lowell Fertilizer Co., Boston, Mass.
8083	Fine Ground Bone.	Pacific Guano Co., Boston, Mass.
8241	Ground Bone.	Plumb & Winton Co., Bridgeport.
6792	Pure Fine Bone.	Darling Fertilizer Co., Pawtucket, R. I.
8046	Swift Sure Bone Meal.	M. L. Shoemaker & Co., Philadelphia.
8177	Bone Meal.	Milsom Rendering & Fertilizer Co., Buffalo, N. Y.
8047	Americus Pure Bone Meal.	Williams & Clark Fertilizer Co., N. Y.
6756	Pure Fine Ground Bone.	Rogers Manufacturing Co., Rockfall.
8181	Ground Bone Meal.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.
8750	White Oak Bone.	Clark's Cove Fertilizer Co., N. Y.
8180	Pure Ground Bone.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.
8085	Ground Bone.	Elbert Clinton, Clintonville.
8802†	Fine Ground Bone.	Bradley Fertilizer Co., Boston, Mass.
8243	Pure Ground Bone.	G. W. Miller, Middlefield.
8179	Pure Ground Bone.	Peck Bros., Northfield.
8029	Bone Dust.	Peter Cooper Glue Factory, N. Y.
8182	Ground Bone.	M. E. Wheeler & Co., Rutland, Vt.
8030	Pure Bone Meal.	J. H. Wilson, Norwalk.

† See remarks, page 99.

STATION AGENT. ANALYSES.

Dealer.	Dealer's cash price per ton.	Valuation per ton.	Percentage diff. between cost and valuation.	Chemical Analysis. Nitrogen.	Chemical Analysis. Phos. acid.	Mechanical Analysis. Finer than 1/50 inch.	Mechanical Analysis. From 1/50 to 1/12 inch.	Mechanical Analysis. Coarser than 1/12 inch.
Manufacturer.	**$22.50**	$30.74	*26.8	2.34	26.67	77	15	8
Manufacturer.	**26.00**	28.65	*9.2	4.08	21.42	58	29	13
City Coal & Wood Co., New Britain. H. M. Andrews, Wallingford. E. W. Halliday, Suffield.	35 00 36.00 **32.00**	33.72	*5.1	3.85	26.10	64	34	2
Manufacturer.	30.00	30.76	*2.5	2.16	28.78	64	22	14
Olds & Whipple, Hartford.	**32.00**	31.37	2.0	3.62	25.38	66	19	15
Manufacturer.	**30.00**	29.30	2.4	4.03	24.35	45	33	22
Browning & Gallup, New London.	34.00 **30.00**	29.26	2.5	2.86	25.52	62	22	16
Manufacturer.	**30.00**	28.69	4.6	1.97	26.14	68	23	9
Manufacturers.	**36.00**	34.01	5.9	3.74	25.66	76	23	1
Apothecaries' Hall Co., Waterbury.	**30.00**	28.19	6.4	4.39	22.57	49	21	30
J. P. Barstow & Co., Norwich.	**32.00**	29.96	6.8	2.41	28.17	57	25	18
Carlos Bradley & Son, Ellington.	**28.00**	26.05	7.5	3.21	21.16	59	24	17
Manufacturers.	**30.00**	27.84	7.8	4.27	21.61	47	32	21
Olds & Whipple, Hartford.	**32.00**	29.41	8.8	2.55	26.25	63	23	14
J. P. Barstow & Co., Norwich.	**37.00**	33.63	10.0	5 56	23.19	56	31	13
W. C. Pease, Somers.	**33.00**	29.27	12.7	2.87	25.65	61	22	17
D. B. Wilson & Co., Waterbury.	**30.00**	26.27	14.2	3.23	22.09	56	22	22
Manufacturer.	**30.00**	26.18	14.6	4.36	21.24	34	37	29
Bugbee Bros., Willimantic.	36.00 **36.00**	31.36	14.8	2.27	29.86	62	19	19
John A. Ballard, Thompson.	**30.00**	25.25	17.4	2.84	20.53	56	41	3
M. D. Stanley, New Britain.	**35.00**	29.50	18.6	4.11	25.46	39	34	27
Manufacturer.	**26.50**	22.25	19.1	4.33	21.84	13	26	61
W. B. Martin, Rockville.	**31.00**	25.53	21.4	2.75	20.56	58	40	2
E. E. Scoville, Stamford.	35.00							
Manufacturer.	**28.00**	22.91	22.2	4.25	22.03	20	21	59
Manufacturer. W. H. Scott & Co., Pequabuck.	27.00 28.00 **27.00**	21.95	23.0	4.10	20.87	18	26	56
Apothecaries' Hall Co., Waterbury.	**30.00**	24.30	23.4	1.03	31.45	28	22	50
W. C. Pease, Somers. John Bransfield, Portland.	32.00 30.00 **31.00**	23.26	29.0	3.45	20.53	36	29	35
Manufacturer.	**34.00**	25.36	34.1	4.16	21.71	25	44	31

* Valuation exceeds cost.

MECHANICAL ANALYSES.

	6791	**8802**
Fine, smaller than $\frac{1}{50}$ inch	63	58
Medium, from $\frac{1}{25}$ to $\frac{1}{50}$ inch	24	40
Coarse, larger than $\frac{1}{25}$ inch	13	2
	100	100

CHEMICAL ANALYSES.

Nitrogen	2.18	2.75
Phosphoric Acid	21.74	20.56
Cost per ton	$34.00	31.00
Valuation per ton	$24.62	25.53

2. *Bone Manures Sampled by Manufacturers or by Purchasers.*

In the following table are given eight analyses of this class. The samples sent by manufacturers represent brands which were not found on sale in the State by our sampling agents.

BONE MANURES, SAMPLED BY THE MANUFACTURERS (☞)

Station No.	Name or Brand.	Manufacturer or Dealer.	Sampled by
8247	Ground Bone.	John G. Jefferds, Worcester, Mass.	John G. Jefferds, Worcester, Mass.
8246	Cyclone Bone Meal.	Milsom Rendering & Fertilizer Co., East Buffalo, N. Y.	Milsom Rendering & Fertilizer Co., East Buffalo, N. Y.
6780	Raw Bone.	S. J. Hall, Meriden.	J. Norris Barnes, Yalesville.
8128	Fine Ground Bone.	Lowell Fertilizer Co., Boston, Mass.	H. C. Dunham, Middletown.
6693	Fine Ground Bone.	L. Sanderson, New Haven.	W. L. & S. T. Merwin, Milford.
8270	Fine Ground Bone.	L. Sanderson, New Haven.	H. C. C. Miles, Milford.
8056	Bone.	George F. Taylor, New York	A. E. Plant, Branford.
8242	Pure Ground Bone.	Wilcox Fertilizer Works, Mystic.	M. E. Thompson, Ellington.

The Station is responsible for the correct subdivision and analysis of the small samples placed in its possession, but not for the accuracy with which those samples represent the several articles specified.

TANKAGE.

After boiling or steaming meat scrap, bone and other slaughter-house waste, fat rises to the surface and is removed, the soup is run off, and the settlings are dried and sold as tankage. As analyses show, tankage has a very variable composition. In general it contains more nitrogen and less phosphoric acid than bone.

In the table, page 104, are given fifteen analyses of this material: five of the samples were drawn by the Station agent, one by a manufacturer and nine by purchasers.

DRY GROUND FISH.

This residue from the manufacture of fish oil is often sprinkled with diluted oil of vitriol, to hinder decay during drying, whereby the fish bones are softened and to some extent dissolved.

Seven analyses of this article are given on pages 104 and 105:

OR BY PURCHASERS. ANALYSES.

Station No.	Dealer's cash price per ton.	Valuation per ton.	Chemical Analyses.		Mechanical Analyses.		
			Nitrogen.	Phos. Acid.	Fine, smaller than 1/50 inch.	Medium, from 1/50 to 1/12 inch.	Coarse, larger than 1/12 inch.
8247	....	$33.28	2.14	29.58	77	18	5
8246	....	25.76	4.08	24.58	26	27	47
6780	....	19.79	3.00	15.66	48	28	24
8128	$23.00	29.94	3.22	24.38	66	24	10
6693	30.00	24.64	4.24	23.04	24	26	50
8270	30.00	28.67	5.82	17.73	57	20	23
8056	...	30.75	2.73	27.27	63	23	14
8242	29.00	26.81	4.54	21.47	42	24	34

MIXED FERTILIZERS.

BONE AND POTASH.

8025. Square Brand Bone and Potash, made by the Bowker Fertilizer Co., Boston, Mass. Sampled from stock of D. B. Wilson & Co., Waterbury, and C. T. Leonard, Norwalk.

TANKAGE. (☞)

Station No.	Name or Brand.	Dealer.
	Sampled by Station Agent.	*Dealer.*
8235	High Grade Tankage.	Wilcox Fertilizer Works, Mystic.
6793	Tankage.	Quinnipiac Co., Boston.
6727	Blood, Bone and Meat.	L. Sanderson, New Haven.
6702	Tankage.	S. D. Woodruff & Sons, Orange.
	Sampled by Dealer.	
8063	Dried Blood and Meat.	E. E. Burwell, New Haven.
	Sampled by Purchasers.	
6563	Ground Tankage.	Berkshire Mills, Bridgeport.
6735	Tankage.	McQuaid Bros, Worcester, Mass.
6722	Tankage.	Quinnipiac Co., Boston, Mass.
8016	Tankage.	G. F. Taylor & Son, New York City.
6561	Tankage.	Olds & Whipple, Hartford.
6509	Tankage.	J. W. Daly, Meriden,
6508	Tankage.	J. W. Daly, Meriden.
6510	Tankage.	J. W. Daly, Meriden.
6781	Tankage.	L. H. Francis & Co., Meriden.
8271	Ground Tankage.	G. F. Taylor & Son, New York City.

DRY GROUND FISH (☞)

Station No.	Manufacturer.	Sampled from Stock of	Dealer's Cash Price per Ton.
8201	Luce Bros., Niantic.	F. A. Beckwith, Niantic	$30.00
		Luce Bros., Niantic.	29.00
6692	George W. Miles, Milford.	W. L. & S T Merwin, Milford.	28.00
8216	George W. Miles, Milford.	Manufacturer.	20.00
6770	Quinnipiac Co., Boston, Mass.	Olds & Whipple, Hartford.	32.00
6734		L. Sanderson, New Haven.	30.00
8156	Wilcox Fertilizer Works, Mystic	C. M. Smith, East Hartford.	32.00
		F. S. Bidwell Windsor Locks.	21.00
		H. K. Brainard, Thompsonville.	30.00
8239	Wilcox Fertilizer Works, Mystic.	M. E. Thompson, Ellington.	30.00

8203. Ground Bone and Potash. Made by the E. Frank Coe Fertilizer Co., New York. Sampled from stock of W. B. Martin, Rockville, and D. N. Benton, Guilford.

ANALYSES AND VALUATIONS.

	Dealer's Cash Price per Ton.	Valuation per ton.	Percentage Diff. between Cost and Valuation.	Chemical Analysis.		Mechanical Analysis.		
				Nitrogen.	Phosphoric Acid.	Finer than 1/50 inch.	From 1/12 to 1/50 inch.	Coarser than 1/12 inch.
Sampled from Stock of								
Wilcox Fertilizer Works.	**$30.00**	$29.12	3.0	7 46	12.96	61	21	18
Olds & Whipple, Hartford.	**28.00**	26.31	6.4	4.90	16.82	56	29	15
L. Sanderson, New Haven.	**30.00**	25.94	15.6	6.18	13.69	48	34	18
S. D. Woodruff & Sons, Orange.	----	28.30	----	4.84	17.78	71	19	10
E. E. Burwell, New Haven.	**22.00**	21.69	1.4	7.10	2.26	--	--	--
Sampled by								
S. E. Curtis, Stratford.	**20.00**	28.05	28.7*	6.50	14.58	59	22	19
G. S. Butler, Cromwell.	**20.00**	24.49	18.3*	5.09	15.11	42	43	15
F. O. Ives, West Cheshire.	**27.50**	28.29	2.7*	8.07	10.62	55	28	17
A. C. Lake, Bethlehem.	**20.00**	19 53	2.4	6.23	8.64	14	58	28
Olin Wheeler, Buckland.	**28.00**	25 40	10.2	4 58	15.91	64	24	12
L. H. Francis, Meriden.	**21.00**	17.97	16 9	4.76	11.78	28	21	51
L. H. Francis, Meriden.	**21.00**	17.74	18.4	4.05	16.27	12	22	66
L. H. Francis, Meriden.	**21.00**	16.89	24.3	4.06	16.02	8	19	73
J. Norris Barnes, Yalesville.	----	24.40	----	8.79	5.80	39	36	25
H. C. C. Miles, Milford.	**†18.00**	27.33	34.1*	4.99	16.21	70	22	8

ANALYSES.

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.				Phosphoric Acid.						
		Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen,		Soluble.	Reverted.	Insoluble.	Total.		Available.	
				Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.
$30.00	3.3*	1.54	6.62	8.16	*8.2*	.96	6.00	.59	7.55	*6.4*	6.96	....
27.63	1.3	1.16	6.02	7.18	....	1.15	6.08	.73	7.96	....	....	....
....	....	1.23	5 84	7 07	*8.0*	....	....	....	....	....	....	....
32.33	1.0*	.56	8.63	9.19	....	.77	5.58	.57	6.92	....	6.35	....
31.66	5.2*	.10	8.83	8.93	....	.58	5.42	1.52	7.52	....	6.00	....
30.92	2.9*	.26	8.34	8 60	*8.5*	.75	4.77	3.18	8.70	*6.0*	5 52	*4.0*
31.75	5 5*	.34	8.68	9.02	....	.69	4.66	2.77	8.12	....	5.35	....

8149. Dissolved Bone and Potash. Made by the Milsom Rendering and Fertilizer Co., Buffalo, N. Y. Sampled from stock of J. R. Gilbert, Gilead, and J. O. Lincoln, Berlin.

* Valuation exceeds cost. † Car-lot price.

8231. Soluble Bone and Potash. Made by the Great Eastern Fertilizer Co., Rutland, Vt. Sampled from stock of Silas Finch, Greenwich, and F. V. Cantrell, Darien.

ANALYSES OF BONE AND POTASH.

	8025	8203	8149	8231
Organic Nitrogen	1.81	2.01	none	none
Soluble Phosphoric Acid	----	----	6.10	7.39
Reverted " "	----	----	3.90	3.57
Insoluble " "	----	----	.40	1.90
Total " "	13.13	17.42	10.40	12.86
Potash	2.26	3.10	1.50	3.25
Cost per ton	$28.00	28.00	31.00	24.00
Valuation per ton	$18.05	22.78	12.12	15.39

Nos. **8149** and **8231** are mixtures of acid phosphate and potash salts. They contain no nitrogen and are not "Bone and Potash" in the accepted meaning of the term.

NITROGENOUS SUPERPHOSPHATES AND GUANOS.

Here are included those mixed fertilizers containing nitrogen, phosphoric acid, and in most cases, potash, which are not designed by their manufacturers for use on any special crop. "Special Manures" are noticed further on.

1. *Samples drawn by Station Agents.*

In the tables on pages 108 to 117 are given analyses of 101 samples belonging to this class, arranged according to the percentage differences between their cost prices and valuations.

GUARANTEES.

Of the one hundred and one analyses of nitrogenous superphosphates, given in the tables, twenty are below the manufacturer's minimum guarantee in respect of one ingredient and two in respect of two ingredients.

The number which failed to come up to the guarantee is considerably smaller than in the previous year.

Usually the deficiency of one ingredient in the mixture has been made up by a surplus of another, indicating that the lack of agreement between actual and guaranteed composition was caused by defects in mixing or by a mechanical separation of the ingredients after mixing.

COST AND VALUATION.

Cost.

The method used to ascertain the retail cost price of the superphosphates is as follows:

The sampling agents inquire and note the price at the time each sample is drawn. The analysis, when done, is reported to each dealer from whom a sample was taken, with an enclosed postal card addressed to the Station, and a request to note on it whether the retail cash price is correctly given and to mail to the Station.

From the data thus obtained the average prices are computed.

Valuation.

The valuation has been computed in all cases in the usual manner as explained on page 83.

Percentage difference given in the table shows the percentage excess of the cost price over the average retail cost of the nitrogen, phosphoric acid and potash contained in the fertilizer.

This information enables the purchaser to estimate the comparative value of different brands and to determine whether it is better economy to buy the commercial mixed fertilizers of which so many are now offered for sale, or to purchase and mix for himself the raw materials.

Which plan is preferable can only be determined by each individual farmer, who should know best what his soil and crops need and what his facilities for purchase and payment are.

In case a fertilizer has sold at two or more different prices, the *manufacturer's price*, when known, has been used in calculating percentage difference.

Otherwise an *average, or nearly average price*, forms the basis of comparison between cost and valuation. The price thus employed is printed in heavy-faced type.

The average cost of the nitrogenous superphosphates is $30.44. The average valuation is $20.71, and the percentage difference 46.9.

Last year the corresponding figures were:

Average cost $31.56, average valuation $21.18, percentage difference 49.0.

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY STATION.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
8229	Bone, Fish and Potash.	E. R. Kelsey, Branford.	Manufacturer.	**$20.00**
			H. A. Bailey, Clinton.	20.00
			Wilson & Burr, Middletown.	28.00
6794	Pure Fine Bone, Dissolved with Sulphuric Acid.	Mapes, F. & P. G. Co., New York.	Mapes' Branch, Hartford.	**29.00**
8261	Unexcelled Phosphate.	G. W. Miller, Middlefield.	Manufacturer.	**30.00**
8226	Bone, Fish and Potash.	Luce Bros., Niantic.	Manufacturer.	**24.00**
6773	Hubbard's All Crops, All Soils	The Rogers & Hubbard Co., Middletown.	Manufacturer.	**27.00**
8273	Market Garden.	Bowker Fertilizer Co., Boston, Mass.	D. B. Wilson & Co., Waterbury.	**33.00**
				34.00
			W. O. Burr, Fairfield.	32.00
8296	Pequot Fish and Potash.	Quinnipiac Co., Bost., Mass	A. J. Martin, Wallingford.	**22.00**
8223	Standard Superphosphate of Lime.	Lister's Agricultural Chemical Works, Newark.	A. N. Clark, Milford.	**28.00**
8205	Giant Neck Superphosphate	Luce Bros., Niantic.	Manufacturer.	**29.00**
			F. A. Beckwith, Niantic.	30.00
8195	"Ceres" Brand.	G. W. Miles, Milford.	Manufacturer.	**32.00**
8304	Animal G Brand.	Darling Fertilizer Co., Pawtucket, R. I.	J. M. Gager, Willimantic.	**29.00**
8260	Cecrops Fertilizer.	Frederick Ludlam, N. Y.	S. A. Smith, Clintonville.	**35.00**
8227	Fish and Potash.	Rogers Mfg. Co., Rockfall.	J. A. Lewis, Willimantic.	**25.00**
8321	"Star" Bone Phosphate.	Tygert-Allen Fertilizer Co., Philadelphia.	Smith & Son, West Cornwall.	**25.00**
8044	Swift Sure Superphosphate.	M. L Shoemaker & Co., Philadelphia	F. Ellsworth, Hartford.	**35.00**
			J. P. Barstow & Co., Nor'h.	36.00
8224	Fisherman's Brand Fish and Potash.	Bowker Fertilizer Co., Boston, Mass.	G. F. Walters, Guilford.	**24.00**
8015	Market Garden Manure.	Quinnipiac Co., Boston, Mass.	Olds & Whipple, Hartford.	36.00
			A. P. Wakeman, Fairfield.	32 00
				34.00
8286	Garden and Lawn.	Darling Fertilizer Co., Pawtucket, R. I.	J. M. Gager, Willimantic.	**36.00**
8041	Ammoniated Bone Phosphate.	Wilcox Fertil'r Co., Mystic	Browning & Gallup, N. L'n.	31.00
			J. W. Dennison & Co., Mystic.	28.00
				29.00
8164	Gardener's Complete Manure.	Packer's Union Fertilizer Co., New York.	Rockville Milling Co., Rockville.	**35.00**
			W. D. Wanzer, Lanesville.	36.00
8225	Success Phosphate.	Lister's Agricultural Chemical Works, New'k, N. J.	A. N. Clark, Milford.	**26.00**
8155	Vegetable Manure or Complete Manure for light Soils.	Mapes F. & P. G. Co, New York.	J. P. Barstow & Co., Norwich.	40.00
			Mapes' Branch, Hartford.	**39.00**
8022	Complete Manure, A Brand.	Mapes F. & P. G. Co, New York.	J. M Page & Co., Naugat'k.	40.00
			Mapes' Branch, Hartford.	33.00
				34.00
8076	Vegetable Bone Fertilizer.	Milsom Rendering and Ferti'r Co., E. Buffalo, N. Y.	W. C. Pease, Somers.	**35.00**
			J. R. Gilbert, Gilead.	35.00
8100	Essex XXX Fish and Potash.	Russia Cement Co., Gloucester, Mass.	F. E. Wheeler & Co., Watertown.	30.00
			H. C. Aborn & Son, Ellin'n.	28.00
				29.00

Analyses—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate	Total.	
$19.54	3.3	----	.65	3.11	3.76	3.3	2.83	1.80	.24	4.87	4.0	4.63	----	.63	4.12	4.0
26.91	7.8	----	----	2.75	2.75	2.1	4 84	13.51	.95	19.30	----	18.35	12.0	----	----	----
26.96	11.3	.06	----	1.80	1.86	1.5	5.46	6.91	.99	13.36	11.0	12.37	----	9.37	9.37	8.0
21.08	13.9	----	1.05	2.63	3.68	3.3	2.56	3.28	.52	6.36	4.0	5.84	----	.64	4.63	4 0
23.68	14.0	.66	----	1.67	2.33	2.3	8.21	4.66	1.01	13.88	12.0	12.87	10.0	3.40	3.40	3.0
26.99	22.3	.77	----	1.85	2.62	2.2	4.51	3.92	2.28	10.71	8.0	8.43	5.0	10.96	10.96	10.0
17.93	22.6	----	.52	2 25	2.77	2.5	1.71	4.85	3.19	9.75	7.0	6.56	6.0	2.46	2.46	2.0
22.64	23.7	----	.54	2.18	2.72	2.3	10.48	1.42	.91	12.81	12.0	11.90	10.0	1.97	1.97	1.5
23.33	24.3	----	1.10	2.87	3.97	3.3	2.69	3.52	.46	6.67	6.0	6.21	----	.77	5.74	5.0
25.46	25.7	1.02	.47	1.96	3.45	3.3	4.22	3.73	2.32	10.27	10.0	7.95	8.0	.50	6.59	7.0
22.71	27.7	----	.14	2.63	2.77	2.0	4.35	5.35	2.56	12.26	7.0	9.70	----	4.23	4.23	4.0
27.40	27.7	.71	.16	2.56	3.43	3.0	7.65	2.84	.60	11.09	----	10.49	7.0	7.01	7.01	7.0
19.53	28.0	----	----	3 30	3.30	3.2	1.50	3.18	3.37	8.05	6.0	4 68	----	4.57	4 57	3.7
19.41	28.8	---	----	2.10	2.10	1.9	8.00	1.78	1.13	10.91	10.5	9.78	8.5	2.78	2.78	2.5
27.08	29.2	.82	----	2.15	2.97	2.5	9.79	3.53	.93	14.25	9.0	13.32	----	.49	4.14	4.0
18.48	29.9	.15	.16	2.36	2.67	2.2	3.02	2.87	1.33	7.22	6.0	5.89	4.0	4.78	4.78	5.0
25.87	31.6	----	.88	2.55	3.43	3.3	4.82	4.07	1.77	10.66	9.0	8.86	8.0	6.97	6.97	7.0
27.36	31.6	.75	.16	3.07	3.98	4.0	3.73	5 48	3.22	12.43	10.0	9.21	----	5.96	5.96	5.0
21.91	32.4	.06	.37	2.58	3.01	2.5	2.46	5.21	1.49	9.16	7.0	7.67	6.0	5.55	5.55	5.0
26.30	33.1	----	----	2.54	2.54	2.5	4.45	4.54	2.22	11.21	----	8.99	8.0	9.23	9.78	10.0
19.09	36.2	----	----	1.56	1.56	1.2	8.62	2.48	1.68	12.78	11.5	11.1	9.5	1.78	2.27	2.0
28.59	36.4	.72	1.12	3.03	4.87	4.9	4.29	3.87	1.50	9.66	8.0	8.16	6 0	6.53	6.53	6.0
24.89	36.6	.54	.47	1.97	2.98	2.5	7.94	4.74	.59	13.27	12.0	12.68	10.0	3.20	3.20	2.5
25.53	37.1	----	----	3.92	3.92	4.1	7.44	1.41	.72	9.57	9.0	8.85	8.0	5.19	5.19	5.0
21.12	37.3	----	----	2.30	2.30	2.1	3.66	7.16	3.88	14.70	12.0	10.82	----	2.15	2.15	2.2

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
8215	Fish and Potash, Square Brand.	Bowker Fertilizer Co., Boston, Mass.	C. W. Michaels & Co., Yalesville.	**$28.00**
8175	Ammoniated Bone and Potash.	Armour Fertilizer Co., Chicago, Ill.	William Crane, Brd. Brook.	**32.00**
8290	Concentrated Phosphate.	Cumberland Bone Phosphate Co., Boston, Mass.	D. C. Spencer, O. Saybrook.	**36.00**
6777	Complete Fertilizer.	Berkshire Mills, Bridgeport.	Manufacturer.	**34.00**
8011	Ammoniated Bone Phosphate.	National Fertilizer Co, Bridgeport.	A H Cashen, Meriden.	**28.00**
			Manufacturer.	28.00
8096	All Soluble.	Armour Fertilizer Co., Chicago, Ill.	Wm. Crane, Broad Brook.	37.00
			E. A. Buck & Co., Willim'c.	35.00
				36.00
8340	Formula A.	L. Sanderson, New Haven.	George Harper, Watertown.	**35.00**
8291	Complete Manure for General Use.	H. J. Baker & Bro., New York.	W. F. Andross, East Hartford.	**33.00**
8034	Complete Fertilizer.	National Fertilizer Co., Bridgeport.	F. Hallock, Derby.	40.00
			Manufacturer.	35.00
			J. T. Buckhaut, Greenwich.	40.00
				38.00
8198	High Grade Fish and Potash.	Wilcox Fertilizer Works, Mystic.	Browning & Gallup, New London.	30.00
			Manufacturer.	32.00
				31.00
8292	Vegetable Bone Superphosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Bronson Bros. & Co., Winchester Center.	**39.00**
8324	Ammoniated Bone Superphosphate	Preston Fertilizer Co., Greenpoint, L. I.	Newell St. John, Simsbury.	**30.00**
8323	Imperial Superphosphate.	Henry F. Tucker, Boston, Mass.	E. A. Buck & Co., Willimantic.	**27.00**
8097	Hill and Drill Phosphate.	Bowker Fertilizer Co., Boston, Mass.	E. F. Miller, Ellington.	**33.00**
			Jas. A. Nichols, Danielson.	37.00
8091	Complete Bone Superphosphate.	Wilcox Fertilizer Works, Mystic.	Browning & Gallup, New London.	**29.00**
			A. P. Lathrop, Andover.	31.00
8298	Fish and Potash, Crossed Fishes Brand.	Quinnipiac Co, Boston, Mass.	Olds & Whipple, Hartford.	**32.00**
8320	Standard Bone Phosphate.	Tygert-Allen Fertilizer Co., Philadelphia.	Smith & Son, West Cornwall.	**25.00**
8326	Standard U. X. D. Fertilizer.	H. J. Baker & Bro., New York.	W. F. Andross, East Hartford.	**28.00**
8258	Great Planet A.	Clark's Cove Fertilizer Co., New York.	F. M. Payne, Moosup.	**38.00**
8012	Market Garden Fertilizer.	National Fertilizer Co., Bridgeport.	Manufacturer.	33.00
			J. T. Buckhaut, Greenwich.	32.00
				32.50
8068	Phosphate.	Quinnipiac Co., Boston, Mass.	W. C. Pease, Somers.	33.00
			C. A. Young, Danielson.	30.00
				31.50
8299	Universal Fertilizer.	Packer's Union Fertilizer Co., New York.	Rockville Milling Co., Rockville.	**27.00**
8120	Animal Fertilizer.	Lowell Fertilizer Co, Boston, Mass.	N. N. King, Thompson.	35.00
			Edward White, Rockville.	**34.00**

ANALYSES—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
$20.26	38.2	....	.34	2.62	2.96	*2.2*	3.78	2.75	2.66	9.19	*8.0*	6.53	....	4.48	4.48	*4.0*
23.02	39.0	....	....	3.28	3.28	*2.5*	4.72	5.06	2.26	12.04	*8.0*	9.78	*6.0*	1.94	2.88	*2.0*
25.84	39.3	....	1.00	2.48	3.48	*3.3*	5.95	3.14	.77	9.86	*10.0*	9.09	*9.0*	6.89	6.89	*7.0*
24.30	39.9	.43	....	2.16	2.59	*2.5*	5.98	3.52	1.63	11.13	*10.0*	9.50	*8.0*	.81	6.38	*6.0*
19.99	40.0	....	....	1.97	1.97	*1.6*	6.51	4.49	1.45	12.45	*9.0*	11.00	*7.0*	2.49	2.49	*2.0*
25.68	40.1	.46	....	2.94	3.40	*2.2*	4.62	5.42	.91	10.95	*10.0*	10.02	*8.0*	.28	5.33	*4.0*
24.84	40.9	.24	1.23	1.97	3.44	*3.3*	3.04	4.48	1.77	9.29	*10.0*	7.52	*7.0*	7.56	7.56	*6.0*
23.24	41.9	.56	1.01	1.53	3.10	*2.5*	7.02	1.30	.17	8.49	*9.0*	8.32	*8.0*	6.19	6.19	*6.0*
26.75	42.1	....	1.11	2.50	3.61	*3.3*	6.66	2.98	1.43	11.07	*10.0*	9.64	*8.0*	6.52	6.52	*6.0*
21.81	42.1	....	.34	3.46	3.80	*3.2*	3.42	2.65	.71	6.78	*6.0*	6.07	*5.0*	5.01	5.01	*4.0*
27.29	42.9	....	.20	4.72	4.92	*5.0*	6.35	.91	.47	7.73	....	7.26	*6.0*	6.04	6.04	*6.0*
21.00	42.9	.12	.22	1.40	1.74	*2.0*	4.58	7.79	3.75	16.12	....	12.37	*9.0*	2.02	2.02	*2.0*
18.88	43.0	....	....	2.14	2.14	*1.0*	5.25	4.59	1.90	11.74	*11.0*	9.84	*9.0*	1.96	1.96	*1.8*
23.01	43.4	.67	....	2.03	2.70	*2.5*	9.20	2.78	1.13	13.11	*12.0*	11.98	*9.0*	2.33	2.33	*2.0*
20.16	43.8	.04	.20	2.42	2.66	*2.0*	2.56	5.80	2.42	10.78	*9.0*	8.36	*8.0*	3.49	3.49	*3.0*
22.17	44.3	....	.52	3.27	3.79	....	2.88	3.61	1.75	8.24	....	6.49	....	1.23	4.25	....
17.25	44.9	....	....	1.90	1.90	*1.6*	7.34	1.52	1.12	9.98	....	8.86	*8.0*	2.10	2.10	*2.0*
19.23	45.6	.31	.82	1.37	2.50	*1.6*	6.43	2.33	1.00	9.76	....	8.76	*8.0*	2.79	2.79	*2.0*
25.79	47.3	....	.89	2.61	3.50	*4.0*	5.31	3.36	1.41	10.08	*9.0*	8.67	*8.0*	7.02	7.02	*7.0*
21.99	47.8	....	1.22	1.38	2.50	*2.5*	4.99	2.91	1.51	9.41	*9.0*	7.90	*7.0*	5.60	6.40	*6.0*
21.30	47.9	.31	....	2.46	2.77	*2.5*	6.03	4.19	1.95	12.17	*10.0*	10.22	*9.0*	2.15	2.15	*2.0*
18.18	48.5	.08	....	1.34	1.42	*.8*	5.33	3.34	1.60	10.27	....	8.67	*8.0*	4.85	4.85	*5.0*
22.86	48.7	....	....	2.93	2.93	*2.5*	6.96	3.34	1.19	11.49	*10.0*	10.30	*9.0*	1.87	8.37	*4.0*

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
8167	Fish and Potash.	Read Fertilizer Co., New York.	E. E. Pitney, Ellington. B. H. Saunders, Collinsville.	$29.00 **28.00**
8074	New Method Fertilizer.	Bradley Fertilizer Co., Boston, Mass.	S. A. Billings, Meriden. J. A. Lewis, Willimantic.	33.00 30.00 **31.50**
8204	Gold Brand Excelsior Guano.	E. Frank Coe, New York.	C. D. Way, Gilead. D. N. Benton, Guilford.	35.00 **34.00**
8148	Soluble Pacific Guano.	Pacific Guano Co., Boston, Mass.	E. A. Halliday, Suffield. T. B. Wickwire, Berlin.	...... 35.00 **30.00**
8303	Essex High Grade Superphosphate.	Russia Cement Co., Gloucester, Mass.	F. E. Wheeler & Co., Watertown.	**38.00**
8312	Ammoniated Dissol. Bone.	Lister's Agricultural Chemical Works, Newark, N. J.	J. A. Foster, Stafford Springs.	**30.00**
8197	Triumph.	Niagara Fertilizer Co., Buffalo, N. Y.	J. W. Everle, Stratford. J. H. Day, Jr., Old Saybrook.	32.00 28.00 **30.00**
8309	Bay State Fertilizer.	Clark's Cove Fertilizer Co., New York.	Henry Fields, Newington.	**32.00**
8118	Swift's Lowell Complete Manure.	Lowell Fertilizer Co., Boston, Mass.	W. D. Penfield, Cobalt. J. F. Sheridan & Bro., Manchester. Edward White, Rockville. C. N. Jones, Wallingford. S. H. Bowen, Brooklyn. C. W. Lines, New Britain.	**33.00** 33.00 33.00 32.00 33.00 30.00
8344	High Grade Farmer's Friend.	Read Fertilizer Co., New York.	O. E. Bailey, Buckingham.	**40.00**
8265	High Grade Farmer's Friend.	Read Fertilizer Co., New York.	J. T. Sliney, Branford.	......
8165	Alkaline Bone Superphosphate.	E. Frank Coe, New York.	Swenson & Folke, Stamford. S. E. Brown, Collinsville.	27.00 30.00 **28.00**
8194	Ammoniated Bone Superphosphate.	G. W. Miles, Milford.	S. J. Hall, Meriden. Manufacturer.	30.00 25.00 **27.50**
8339	Old Reliable.	L. Sanderson, New Haven.	George Fisk, Rockville.	**30.00**
8168	Harvest Home Phosphate.	H. J. Baker & Bro., New York.	S. J. Hall, Meriden. F. N. Konold, Collinsville.	25.00 28.00 **26.00**
8081	Americus Ammoniated Bone Superphosphate.	Williams & Clark Fertilizer Co., New York.	John Bransfield, Portland. D. B. Wilson & Co., Waterbury.	35.00 32.00 **33.50**
8169	Farm and Garden or Ammoniated Bone.	Bowker Fertilizer Co., Boston, Mass.	S. E. Brown, Collinsville. C. T. Leonard, Norwalk.	35 00 38.00 **28.00**
8007	AA Ammoniated Bone Superphosphate.	H. J. Baker & Bro., New York.	S. J. Hall, Meriden. R. & D. Loudon Bros., Winipauk.	**35.00** 35.00
8080	Sure Crop Phosphate.	Bowker Fertilizer Co., Boston, Mass.	C. T. Leonard, Norwalk. F. A. Nettleton, Durham Center.	32.00 26.00 **25.00**

ANALYSES—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Found.	
$18.76	49.3	.04	....	2.90	2.94	*2.5*	3.57	1.96	1.20	6.73	*5.0*	5.53	*4.0*	4.62	4.62	*4.0*
21.30	47.9	.32	....	2.34	2.66	*1.6*	5.90	3.69	1.66	11.25	*10.0*	9.59	*8.0*	3 34	3.34	*3.0*
22.52	50.9	....	.88	1.66	2.54	*2.0*	6.42	1.81	1.71	9.94	*9.0*	8.23	*8.0*	.56	6.00	*6.0*
19.86	51.0	.14	.31	2.10	2.55	*2.2*	5.79	3.67	1.91	11.37	*10.5*	9.46	*8.5*	2.17	2.17	*2.0*
25.14	51.2	.50	....	2.49	2.99	*2.5*	3.81	7.02	2.73	13 56	*11.0*	10.83	*9 0*	4 97	4.97	*4.0*
19.79	51.6	....	....	1.94	1.94	*1.8*	6.83	4.40	1.83	13.06	*11 0*	11.23	*9.0*	1.91	1.91	*1.*
19.77	51.7	....	....	2.38	2.38	*2.5*	6.80	2.79	2.37	11.96	....	9.59	*8.0*	2.10	2.10	*2.1*
20.20	53 1	....	.50	2.15	2.65	*2.5*	6.50	4.16	1.48	12.14	*10.0*	10.66	*9.0*	1.81	1.81	*2.0*
21.56	53.1	....	....	2.48	2.48	*2.0*	5.87	4.24	1.81	11.92	*9.0*	10.11	*8.0*	2.38	3.44	*3 5*
25.99	53.9	....	.86	2.72	3.58	*3.2*	4.43	2.34	.94	7.71	*6.0*	6.77	*5.0*	9 40	9.40	*10.0*
*	....	....	.22	2.43	2.65	*3.2*	5.57	1.94	1.06	8.57	*6.0*	7.51	*5.0*	7.79	7.79	*10.0*
18.14	54.4	....	....	1.49	1.49	*1.2*	7.70	2.50	2.76	12.96	*11.0*	10.2	*9.0*	.37	1.94	*1.9*
17.80	54.5	.10	.42	1.74	2.26	*2.0*	4.88	2.45	4.45	11.78	*9.0*	7.33	*8.0*	2.13	2.13	*2.0*
19.42	54.5	.31	1.10	1 14	2.25	*1.6*	2.32	5.00	3.64	10 96	*10.0*	7.32	*7.0*	3.76	3.76	*2.0*
16.72	55.5	....	.32	1.15	1.47	*1.0*	6.02	3.18	1.49	10.69	*9.0*	9.20	*8.0*	2.49	2.49	*2.0*
21.48	55.9	.09	.25	2.43	2.77	*3.0*	6.48	4.17	1.70	12 35	*10.0*	10.65	*9.0*	1.97	1.97	*2.0*
17.77	57.6	.25	....	1 64	1.89	*1.5*	3.02	5.57	4.18	12.77	*10.0*	8.59	*8.0*	2.13	2.13	*2.0*
22.14	58.1	.31	1.39	1.16	2.86	*2.5*	8.94	1.70	.71	11.35	*11.0*	10.64	*10.0*	2.73	2.73	*2.0*
15.72	59.0	.13	....	.92	1.05	*0.8*	5.12	4.45	3.96	13.53	*10.0*	9.57	*8.0*	1.24	1.24	*1.0*

* Valuation not given for reasons stated, see p. 118.

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
8008	Superphosphate.	Bradley Fertilizer Co., Boston, Mass.	E. E. Scoville. Stamford.	$35.00
			Raymond Bros., S. Norwalk.	33.00
			S. A. Billings, Meriden.	36 00
			Wheeler & Howes, Bridgeport.	33.00
				34.00
8088	New Rival Ammoniated Superphosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Henry Davis, Durham Center.	28.00
			J. E. Leonard & Son, Jewett City.	**27.00**
8114	Ammoniated Bone Phosphate.†	Berkshire Mills, Bridgeport.	Johnson Bros., Jewett City.	27.00
			T. H. Eldridge, Norwich.	32.00
				29.50
8045	High Grade Ammoniated Bone Superphosphate.	E. Frank Coe, New York.	J. P. Barstow & Co., Norwich.	32.00
			Swenson & Folke, Stamford.	30.00
				31.00
8170	Eclipse Phosphate.	Bradley Fertilizer Co., Boston, Mass.	Loomis Bros., Granby.	28.00
			C. F. Tallard & Son, Broadbrook.	30.00
				29.00
8117	B. D. Sea Fowl Guano.	Bradley Fertilizer Co., Boston, Mass.	F. S. Bidwell, Windsor Locks.	30.00
			W. W. Cooper, Suffield.	32.00
				31 00
8311	Dissolved Bone and Potash.	Lowell Fertilizer Co., Boston, Mass.	G. W. Bancroft, E. Windsor Hill.	**30.00**
			J. C. Lincoln, Berlin.	30.00
8200	Superphosphate.	Cumberland Bone Phosphate Co., Boston, Mass.	D. C. Spencer. Saybrook.	32.00
			William Bartell, Ore Hill.	31.00
				31.50
8119	Swift's Lowell Bone Fertilizer.	Lowell Fertilizer Co., Boston, Mass.	J. F. Sheridan & Bro., Manchester.	30.00
			W. D. Penfield, Cobalt.	30.00
			H. C. Aborn & Son, Ellington.	30.00
			J. E. Leonard & Son, Jewett City.	27.00
			S. H. Bowen, Brooklyn.	30.00
			C. W. Lines, New Britain.	28 00
				29.00
8804	Chittenden's Fish and Potash.	National Fertilizer Co., Bridgeport.	T. H. Eldridge, Norwich.	32.00
			F. A. Nettleton, Durham Center.	27.00
			S. A. & H. B. Williams, Silver Lane.	31.00
				30.00
6775	O. & W. Special Phosphate.	Olds & Whipple, Hartford.	Manufacturer.	**35.00**
8206	Fish and Potash, Triangle A Brand.	Bradley Fertilizer Co, Boston, Mass.	A. J. Ives, Yalesville.	28.00
			G. W. Dennison, Old Saybrook.	30.00
				29.00
8228	Standard Fertilizer.	Standard Fertilizer Co., Boston, Mass.	W. E. Truesdell & Co., Burnside.	**32.00**
			N. S. Bushnell, Taftville.	......

† See page 118.

ANALYSES—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
$21.37	59.1	.14	....	2.55	2.69	*2.5*	6.70	4.06	1.56	12.32	*11.0*	10.76	*9.0*	1.99	1.99	*2.0*
16.95	59.3	....	....	1.36	1.36	*1.2*	7.60	2.61	1.23	11.44	....	10.21	*10.0*	1.87	1.87	*1.6*
18.52	59.3	....	....	2.09	2.09	*1.7*	3.07	4.26	6.63	13.96	*10.0*	7.33	*8.0*	2.64	2.64	*2.0*
19.36	60.1	....	.54	1.67	2.21	*2.0*	7.20	2.39	2.46	12.05	*11.0*	9.59	*9.0*	.30	1.96	*1.9*
18.07	60.5	....	....	1.94	1.94	*1.0*	6.22	3.29	2.03	11.54	*12.0*	9.51	*10.0*	1.89	1.89	*1.5*
19.18	61.6	....	....	2.33	2.33	*2.0*	5.50	3.95	2.63	12.08	*10.0*	9.45	*8.0*	1.79	1.79	*1.5*
18.43	62.7	....	....	1.70	1.70	*1.6*	5.84	4.46	2.35	12.65	....	10.30	*9.0*	2.05	2.05	*2.0*
19.23	63.8	....	....	2.28	2.28	*2.0*	5.86	3.64	1.99	11.49	*10.0*	9.50	*8.0*	2.18	2.18	*2.0*
17.54	65.3	....	....	1.82	1.82	*1.3*	4.51	4.14	1.37	10.02	*9.0*	8.65	*8.0*	2.93	3.08	*3.0*
18.05	66.2	....	....	2.60	2.60	*2.8*	1.94	3.58	3.40	8.92	*6.0*	5.52	....	4.11	4.11	*4.0*
21.02	66.5	....	.59	2.11	2.70	....	6.98	3.41	1.60	11.99	....	10.39	....	.49	1.84	....
17.35	67.1	....	.38	1.89	2.27	*2.0*	2.10	4.12	2.02	8.24	*6.0*	6.22	....	4.21	4.21	*4.0*
19.13	67.3	.06	....	2.18	2.24	*2.0*	6.48	3.11	1.73	11.32	*10.0*	9.59	*8.0*	2.14	2.14	*2.0*

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
8297	Climax Phosphate.	Quinnipiac Co., Boston Mass.	C. A. Young, Danielson.	$26.00
8305	Fish and Potash.	Williams & Clark, New York.	Geo. H. Sloan, Windsorville.	29.00
8095	Royal Bone Phosphate.	Williams & Clark Fertilizer Co., New York.	R. B. Ritter, Brooklyn. Edward L. Strong, Colchester.	28.00 24.00 26.00
8101	Read's Standard.	Read Fertilizer Co., New York.	L. D. Post, Andover. E. E. Pitney, Ellington.	...... 29.00
8222	General Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	James H. Elliott, Campville.	30.00
8288	Economical Bone Fertilizer.	Wilkinson & Co., New York.	W. W. Peck, Woodbridge.	32.00
8082	General Crop Phosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Henry Dawes, Durham Center. Bugbee Bros., Willimantic.	23.00 20.00 21.50
8153	Nobsque Guano.	Pacific Guano Co., Boston, Mass.	John O. Fox & Co., Putnam.	28.00
8221	King Philip.	Clark's Cove Fertilizer Co., New York.	John A. Ballard, Thompson.	28.00
8091	Buffalo Fertilizer.	Milsom Rendering & Fertilizer Co., East Buffalo, N. Y.	J. R. Gilbert, Gilead. Lyman Bros., Columbia.	27.00 27.00
8718	Ammoniated Bone Phosphate †	Berkshire Mills, Bridgeport.	C. L. Swain, Clinton.	35.00
6776	Ammoniated Bone Phosphate	Berkshire Mills, Bridgeport.	Manufacturer.	35.00
8092	Erie King.	Milsom Rendering & Fertilizer Co, East Buffalo, N. Y.	J. R. Gilbert, Gilead. Lyman Bros., Columbia.	25.00 24.00
8313	Cereal Brand.	Fred Ludlam, New York.	S. A. Smith, Clintonville.	30.00
8173	Empire Brand.	Lowell Fertilizer Co, Boston, Mass.	J. E. Leonard & Son, Jewett City. J. F. Sheridan & Bro., Manchester.	27.00 28.00
8151	Guano.	Standard Fertilizer Co., Boston, Mass.	M. E. Truesdell & Co., Burnside. L. Mullaley, Windsor.	28.00 30.00 29.00
8310	Bay State Fertilizer G G.	Clark's Cove Fertilizer Co., New York.	F. M. Payne, Moosup.	35.00
8220	Practical Ammoniated Superphosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Bronson Bros. & Co., Winchester Center.	27.00
8212	Original Coe's Superphosphate	Bradley Fertilizer Co., Boston, Mass.	Wilson & Burr, Middletown.	30.00
8281	Fish and Potash.	Pacific Guano Co., Boston, Mass.	Carlos Bradley & Son, Ellington.	28.00
8001	Special Mixture.	Bowker Fertilizer Co., Boston, Mass.	Manufacturer.	....

† See page 118.

ANALYSES—*Concluded.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
$15.32	69.7	....	....	1.36	1.36	*1.0*	5.86	2.43	1.61	9.90	*9.0*	8.29	*6.0*	2 21	2.21	*2.0*
16.98	70.8	....	.34	1.86	2.20	*2.0*	2.13	3.85	2.07	8.05	*6.0*	5.98	*4.0*	4.26	4.26	*4.0*
15.17	71.4	....	....	1.18	1.18	*1.0*	6.40	2.34	1.46	10.20	*8 0*	8.74	*7.0*	2.12	2.12	*2.0*
16.88	71.8	.17	....	1.15	1.32	*0.8*	6.58	2.05	1.02	9.65	*9.0*	8.63	*8.0*	3.87	3.87	*4.0*
17.34	73.0	.06	....	1.14	1.20	*0.8*	7.23	1.75	.95	9.93	....	8.98	*8.0*	4.33	4.33	*4.0*
18.42	73.7	.12	....	1.16	1.28	*0.8*	7.41	1.68	1.09	10.18	....	9.09	*8.0*	5.07	5.07	*5.0*
12.16	76.7	....	....	1.03	1.03	*0.8*	4.66	2.76	.81	8.23	*7 0*	7.42	*7.0*	1.19	1.19	*1.0*
15.58	79.7	....	....	1.26	1.26	*1.1*	5.04	3.79	2.15	10.98	*9.0*	8.83	*8.0*	2.07	2.07	*2.0*
15.37	82.2	....	....	1.22	1.22	*1.0*	5.31	3.48	1.73	10.52	*9.0*	8.79	*6.0*	2.15	2.15	*2.0*
14.77	82 8	....	....	1.10	1.10	*0.8*	5.46	2.14	1.98	9.58	*9 0*	7.60	*8.0*	2.92	3.04	*4.0*
18.95	84.7	....	....	2.30	2.30	*1.6*	2.43	5.13	6.03	13.59	*10.0*	7.56	....	2.55	2.55	*2 0*
*	....	....	....	1.81	1.81	*1.6*	3.18	4.41	4.09	11.68	*10.0*	7.59	....	2.24	2.24	*2.0*
12.80	87.5	....	....	1.06	1.06	*0.8*	4.93	2.06	2.09	9.08	*9.0*	6.99	*7.0*	1.40	1.65	*2.0*
15.90	88.6	.15	....	0.95	1.10	*0.8*	5.39	4.86	2.77	13.02	*10.0*	10.25	*8.0*	1.02	1.02	*2.0*
14.13	91.2	....	....	1.40	1.40	*1.2*	3.87	3.34	1.35	8.56	*8.0*	7.21	*7.0*	2.14	2.28	*2.0*
15.12	91.8	....	....	1.20	1.20	*1.0*	5 73	2.89	1.55	10.17	*10.0*	8.62	*8.0*	2.17	2.17	*2.0*
18 21	92.2	.21	....	1.99	2.20	*1.6*	5.74	3.25	1.73	10.72	*10 0*	8.99	*8 5*	2.00	2 00	*2.0*
13.35	102.2	....	....	1.07	1.07	*0 8*	5.28	2.83	1.46	9.57	....	8.11	*8.0*	1 26	1.26	*1.0*
*	....	....	....	2.28	2.28	....	5.98	3.92	1.92	11.82	....	9.90	....	1.62	1 62	....
*	....	....	.40	2.09	2.49	....	2.19	4.18	1.93	8.30	....	6.37	....	2.64	2.64	....
*	....	....	1.59	....	2.43	4.02	2.43	6.44	2.27	11.14	....	8.87	....	7.38	7 38	....

* Valuation not given for reasons stated, see p. 118 and 119.

These valuations, it must be remembered, are based on the assumption that the nitrogen, phosphoric acid and potash in each fertilizer are of good quality and readily available to farm crops. Chemical examination shows conclusively whether this is true in respect of potash and phosphoric acid, but gives little or no clue as to the availability of the organic nitrogen of mixed goods. This Station has been for some years engaged in a study of methods for determining approximately the relative availability of nitrogen, and on subsequent pages is given a report of the work done during the past year on this point.

Since various inferior or agriculturally worthless forms of nitrogen are in the market and are known to be used in compounding fertilizers, and cannot as yet be detected with certainty by analysis, the only security of purchasers of mixed fertilizers is in dealing with firms which have the highest reputation and are able to satisfy their customers that they use the best raw materials, and in avoiding "cheap" goods offered by irresponsible parties.

ANALYSES REQUIRING SPECIAL NOTICE.

Five analyses of samples of nitrogenous superphosphates appear in the tables of analyses, pp. 113 and 117, without valuations attached. These require some words of explanation.

6776. Ammoniated Bone Phosphate. Made by the Berkshire Mills, Bridgeport, and sampled at the factory. The manufacturers stated that the analysis did "not fairly represent the bulk of the goods we have put out under that brand, for we know we have put in more nitrogen and more available phosphoric acid." Two other samples of this brand, **8114** and **8748**, were accordingly analyzed with the results given on pages 115 and 117, and repeated in the table on page 119.

8212. Original Coe's Superphosphate. Made by the Bradley Fertilizer Co., Boston, Mass. Sampled from stock of Wilson & Burr, Middletown, which, as was learned after the analysis had been made, was stock carried over from the previous year.

8265. High Grade Farmers' Friend. Made by the Read Fertilizer Co., New York. Sampled from stock of J. T. Sliney, Branford. The Read Fertilizer Co. advised the Station that it makes two brands of High Grade Farmers' Friend, one which is sold almost entirely on Long Island and in New Jersey, the other in New England and New York, and by mistake at the factory the Long Island brand had been shipped to Mr. Sliney. Another analysis made on sample No. **8344**, drawn from stock of O. E. Bailey, Buckingham, is given in the table on page 112, and is here repeated for comparison.

8284. Fish and Potash. Made by the Pacific Guano Co., Boston, Mass. Sampled from stock of Carlos Bradley & Son, Ellington. The manufacturer stated that this analysis did not fairly represent the goods shipped into this State. Other samples of this brand could not be collected. The percentage of potash is 1.36 below the minimum guarantee.

8001. The last analysis in the table is of a Special Mixture, made by the Bowker Fertilizer Co. for the Lordship Park Association, Stratford. Sampled by the Station Agent.

ANALYSES.

	Berkshire Bone Phosphate.			Bradley's Original Coe's Phosphate.	Read's H. G. Farmers' Friend.		Pacific Fish and Potash.	Bowker's Special Mixture.
	6776	**8114**	**8748**	**8212**	**8265**	**8344**	**8284**	**8001**
Nitrogen as nitrates	----	----	----	----	trace	----	----	1.59
" ammonia	----	----	----	----	.22	.86	.40	----
" organic	1.81	2.09	2.30	2.28	2.43	2.72	2.09	2 43
Total Nitrogen	1.81	2.09	2.30	2.28	2.65	3.58	2.49	4.02
Soluble Phosphoric Acid	3.18	3.07	2.43	5.98	5.57	4.43	2.19	2.43
Reverted " "	4.41	4.26	5.13	3.92	1.94	2.34	4.18	6.44
Insoluble " "	4.09	6.63	6.03	1.92	1.06	.94	1.93	2.27
Total " "	11.68	13.96	13.59	11.82	8.57	7.71	8.30	11.14
Potash as muriate	2.24	2.64	2.55	1.62	7.79	9.40	2.64	7.38
" total	2.24	2.64	2.55	1.62	7.79	9.40	2.64	7.38
Cost per Ton	----	$29.50	35.00	30.00	40.00	40.00	28.00	----
Valuation per Ton	$16.64	18.52	18.95	19.11	22.89	25.99	16.67	27.91

2 *and* 3. *Samples drawn by Manufacturers or by Purchasers.*

Analyses of sixteen samples of these two classes are given in the table on pages 120 and 121.

Seven of the samples were sent to the Station by manufacturers in compliance with the fertilizer law. As the brands were not found in market by the Station agents, it was necessary to analyze the samples sent by the manufacturer in order to meet the legal requirement that one or more analyses shall be annually made of every brand sold in the State.

NITROGENOUS SUPERPHOSPHATES SAMPLED BY MANUFACTURERS

Station No.	Name or Brand.	Manufacturer.	Sampled by
8330	Bone, Blood and Potash.	Armour Fertilizer Co., Chicago, Ill.	Manufacturer.
8331	Fish and Potash, Anchor Brand.	Bradley Fertilizer Co., Boston, Mass.	Manufacturer.
8329	Ammoniated Bone Superphosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Manufacturer.
8332	Buffalo Fertilizer.	Milsom Rendering & Fertilizer Co., East Buffalo, N.Y.	Manufacturer.
8333	Four Fold.	Walker, Stratman Co., Pittsburgh, Pa	Manufacturer.
8334	Smoky City.	Walker, Stratman Co., Pittsburgh, Pa.	Manufacturer.
8245	Circle Brand Ground Bone with Potash.	Bradley Fertilizer Co., Boston, Mass.	Manufacturer.
8065	Bone, Fish and Potash.	E. R. Kelsey, Branford.	A. E. Plant, Branford.
8075	Bone, Fish and Potash.	E. R. Kelsey, Branford.	A. H. Griffin, Granby.
8854	Pure Fine Bone, Dissolved in Sulphuric Acid.	Mapes' F. & P. G. Co., New York.	G. B. Porter, Waterbury.
8189	Formula A.	L. Sanderson, New Haven.	Atwater Bros., Cedar Hill.
8238	Swift Sure Superphosphate.	M. L. Shoemaker & Co., Philadelphia Pa. *Stock of F. Ellsworth, Hartford*	M. E. Thompson, Ellington.
8346	XX Special Formula.	C. Buckingham, Southport.	N. H. Sherwood, Southport.
8188	Burwell's A. A. Formula.	E. E. Burwell, New Haven.	J. H. Burton & Sons, New Haven
8181	Burwell's B. B. Formula.	E. E. Burwell, New Haven.	J. H. Burton & Sons, New Haven.
8307	Burwell's Formula.	E. E. Burwell, New Haven.	L. M. Haight, East Haven.

DAMARALAND GUANO.

This material, sold by H. J. Baker & Bro., N. Y., is stated to be a natural guano found at Cape Cross, Damaraland, on the west coast of Africa.

In April a sample, No. **8000**, was sent to the Station by W. F. Andross, East Hartford, drawn from two tons received by him for experimental purposes and stated to show the average mechanical condition.

In May a second sample, No. **8745**, was sent by Mr. Andross, representing stock shipped to J. A. DuBon, Poquonock, for experiment. The analyses are as follows :

OR BY PURCHASERS. ANALYSES.

	Nitrogen.					Phosphoric Acid.							Potash.		
				Total Nitrogen.					Total.		Available.		Found.		
Valuation per Ton.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
$32.64	....	....	5 00	5.00	....	6.77	4.00	.67	11.44	....	10.77	....	.27	6.95	....
20.52	....	....	3.62	3 62	*3.3*	3.30	3.24	1.42	7.96	*5 0*	6.54	*3.0*	3.27	3.74	*3.0*
21.21	....	....	2.94	2.94	*2.9*	9.02	1.71	.40	11.13	....	10.73	*10.0*	1.32	1.32	*1.1*
21.12	....	....	2.41	2 41	....	9.47	.88	.17	10.52	....	10.35	....	.32	3.03	....
15.61	....	. .	1.34	1.34	*0.8*	6.27	3.25	1.00	10.52	*11.0*	9.52	*8.0*	1.45	1.45	*1.0*
20.15	....	....	1.89	1.89	*1.2*	9.28	3.10	.89	13.27	*15.0*	12.38	*12.0*	1 32	1.32	*1.0*
23.64	.05	....	1.99	2.04	*1.9*	3.25	9.03	6.30	18.58	*10.0*	12.28	*6.0*	.30	2.83	*2.0*
18.54	....	.47	3.19	3.66	*3.3*	2.72	1.49	.17	4.38	*4.0*	4.21	....	.52	3.84	*4.0*
19.32	....	.44	3.28	3.72	*3 3*	2.72	1.65	.16	4.53	*4 0*	4.37	....	.60	4.31	*4.0*
27.28	....	....	3.03	3.03	*2.1*	*	....	*	18.89	....	.....	*12.0*	....		....
25.50	.10	2.34	2.28	4.72	....	1.95	5 22	4.20	11.37	....	7.17	....	3.85	3.85	....
26.32	.88	....	2.06	2.94	....	8.91	3.67	1.24	13.82	....	12 58	....	.49	4.17	....
30.91	....	——	4.54	4:54	*4.1*	5.10	3.39	2.63	11.12	*10.0*	8.49	*5 0*	.78	8.23	*8.0*
25.56	1.07	.88	1.73	3.68	*3.3*	3.60	3.63	1.18	8.41	*8.0*	7.23	*7.0*	2.92	7.57	*8 0*
26.55	1.13	.62	2.06	3.81	*3.7*	2.77	6.31	2.11	11.19	*12.5*	9.08	*10.0*	6.18	6.37	*5.5*
26.26	.95	.70	2.35	4.00	*3.7*	6.05	4.44	.51	11.00	*12.0*	10.49	*10.0*	4.07	4.24	*5.5*

	8000	**8745**
Nitrogen as Nitrates	.09	
" Ammonia	3.69	
" Organic	1.84	
" Total	5.62	9.69
Phosphoric Acid, soluble	7.78	
" " reverted "	6.64	
" insoluble	1.02	
" Total	15.44	11.46
Potash	3.42	4.06
Chlorine	4.38	14.62
Valuation	$34.05	

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* Soluble and insoluble phosphoric acid were not determined in this sample. See Analysis No. **6791** in table on page 108.

The material has every appearance of being a natural guano. The two samples are widely different in chemical composition and both contain chlorine in quantity sufficient to make their use on tobacco land unsafe.

SPECIAL MANURES.

Here are included such mixed fertilizers, chiefly nitrogenous superphosphates, as are claimed by their manufacturers to be specially adapted to the needs of particular crops.

1. *Samples drawn by Station Agents.*

In the tables on pages 124 to 135 are given the analyses of one hundred samples drawn by the Station agents and representing ninety-six brands.

GUARANTEES.

Of the one hundred samples analyzed, twenty-five do not fulfill the manufacturer's guarantee as respects one ingredient, and four are each deficient in two ingredients.

The cause of this deficiency is in part explained on page 135.

COST AND VALUATION.

The average cost per ton of the ninety-six brands examined was $34.34, the valuation $24.28, and the percentage difference 41.4.

In 1896 the corresponding figures were: average cost, $36.19; average valuation, $25.64; percentage difference, 41.4.

Analyses requiring Special Notice. See page 134.

8070. Bradley's Complete Manure for Potatoes and Vegetables. Sampled from stocks of J. A. Lewis, Willimantic, and S. A. Billings, Meriden. The percentages of nitrogen and of potash found by analysis are lower than the manufacturer's guarantee. The manufacturer stated that none of this brand had been shipped to Mr. Lewis since March 31, 1896, so that the sample taken from him represented stock more than a year old. Another analysis was therefore made on other samples and is given on page 129, No. **8746.**

8073. High Grade Potato Fertilizer, made by the E. F. Coe Fertilizer Co., N. Y. Sampled from stocks of H. B. Sherwood, Southport, and John O. Fox & Co., Putnam. The sample contained 1.06 per cent. less potash than is guaranteed. The manufacturer stated that this analysis did not fairly represent the general quality of the goods. Another sample was therefore analyzed, No. **8749,** with the results given in the table, page 129.

8103. Americus Potato Phosphate. Made by the Williams & Clark Fertilizer Co., N. Y. Sampled from stocks of W. B. Martin, Rockville, and D. B. Wilson & Co., Waterbury. The sample contained 0.19 per cent. less nitrogen, 1.06 per cent. less potash and 3.20 per cent. more phosphoric acid, than was guaranteed.

The manufacturers stated that the deficiencies of nitrogen and potash were not accounted for by the excess of phosphoric acid, and that they did not believe the sample represented fairly the goods which they had shipped. Another sample was therefore analyzed, No. **8747,** with the results given in the table on page 131.

8021. New England Tobacco and Potato Grower. Made by Crocker Fertilizer Co., Buffalo, N. Y. Sampled from stocks of Meeker Coal Co., Norwalk, and O. H. Meeker, Danbury. The percentages of both nitrogen and potash are below the guarantee of the manufacturer, who claimed that no other analyses had shown such a shortage, and that this analysis did not represent the average character of the goods. Another sample, **8811,** was therefore analyzed with the results given in the table, page 127.

SPECIAL MANURES SAMPLED BY THE STATION.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton
8295	XX Special Formula.	C. Buckingham, Southport.	Manufacturer.	$30.00
8224	Corn Fertilizer.	C. E. Lyman, Middlefield	Manufacturer.	20.00
8316	Seeding Down Manure.	Mapes F. & P. G. Co., New York.	Mapes Branch.	37.00
8264	Hubbard's Fruit Fertilizer.	The Rogers & Hubbard Co., Middletown.	Manufacturer.	40.00
6761	Hubbard's Corn Formula and General Crops	Rogers & Hubbard Co., Middletown.	Manufacturer.	45.00
8259	Potato and Root Crop Manure	Darling Fertilizer Co, Pawtucket, R. I.	W. W. Cooper, Suffield.	32.00
6764	Hubbard's Grass and Grain Fertilizer.	Rogers & Hubbard Co., Middletown.	Manufacturer.	37.50
8084	Essex Complete Manure for Corn, Grain and Grass	Russia Cement Co., Gloucester, Mass.	F. E. Wheeler & Co., Watertown. J. A. Lewis, Willimantic.	38.00 40.00 36.00
8268	Special High Grade Corn Fertilizer.	Rogers Manufacturing Co., Rockfall.	Manufacturer.	46.00
6774	Hubbard's Soluble Tobacco Manure.	Rogers & Hubbard Co, Middletown	Manufacturer.	42.00
8099	Essex Complete Manure for Potatoes, Roots and Vegetables.	Russia Cement Co., Gloucester, Mass.	D. B. Wilson & Co., Waterbury. H. C. Aborn & Son, Ellington	36.00 36.00
6759	High Grade for Oats and Top Dressing.	Rogers Manufacturing Co., Rockfall.	Manufacturer.	42.00
6763	Hubbard's Oats and Top Dressing.	Rogers & Hubbard Co., Middletown.	Manufacturer.	49.00
6760	High Grade Grass and Grain Fertilizer.	Rogers Manufacturing Co., Rockfall.	Manufacturer.	38.00
8266	Essex Special for Tobacco.	Russia Cement Co., Gloucester, Mass.	R. M Burnham, E. Windsor Hill.	43.00
8207	Potato. Onion and Tobacco Manure.	Wilcox Fertilizer Works, Mystic.	C M. Smith, East Hartford. Manufacturer.	34.00 36.00 35.00
8300	Complete Potato and Vegetable Fertilizer.	Rogers Manufacturing Co., Rockfall.	J. A. Lewis, Willimantic.	28.00
6772	Soluble Potato Manure.	Rogers & Hubbard Co., Middletown.	Manufacturer.	38.00
8210	Tobacco Ash Elements.	Bowker Fertilizer Co., Boston. Mass	George M. Risley, Windsor.	32.00
8262	High Grade Soluble Potato and General Crop Manure.	Rogers Manufacturing Co, Rockfall.	Manufacturer.	38.00
8089	Complete Manure for Corn and Grain.	Bradley Fertilizer Co., Boston, Mass.	C. H Baker, Andover. Raymond Bros., South Norwalk.	33.00 34.00
8006	Economical Potato Manure.	Mapes F. & P. G. Co., New York.	Mapes Branch, Hartford. J. H Ray & Son, Greenwich.	33.00 35.00
6762	Complete Corn Manure.	Rogers Manufacturing Co., Rockfall.		36.00

ANALYSES.—*Continued.*

		Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		Available.		Found.		
Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
$31.12	*3.6	.80	.18	3.10	4.08	4.1	3.01	7.05	3.88	13.94	10.0	10.06	5.0	1.04	7.90	8 0
20.90	*0.4	----	----	----	----	----	9.47	3.28	1.02	13.77	----	12.75	10.0	7.54	7.54	8 0
34.41	7.5	.91	----	1.73	2.64	2 5	----†	----	----	17.26	18.0	----	----	12.56	12.56	10.0
36.34	10.0	.18	----	2.94	3.12	2.5	----†	----	----	18.45	17.5	----	----	13.47	13.47	12.5
39.62	13.6	3.46	----	1.75	5.21	5.5	----†	----	----	11.25	12.0	----	----	17.09	17.09	12.0
27.98	14.4	----	.55	3.44	3.99	3.0	2.40	5.50	4.02	11.92	10.0	7.90	----	1.01	7.21	7.0
32.02	17.1	.15	----	2.94	3.09	2.5	----†	----	----	17.94	16.5	----	----	10.77	11.69	12.5
31.84	19.3	.47	----	3.67	4.14	3.7	4.43	6.01	1.51	11.95	10.0	10.44	7.0	9.73	9.73	9.5
38.31	20.0	3.73	----	2.00	5.73	5.5	----†	----	----	12.47	12.0	----	----	13 60	13.60	12 5
34.97	20.1	1.62	1.22	2.52	5.36	5.0	.85	7.99	1.60	10.44	10.0	8.84	7.0	1.14	10.62	10.0
29.74	21.0	.43	.36	3.25	4.04	3.7	4.61	4.23	1.41	10.25	9.0	8.84	7.0	1.26	8.74	8.5
34.65	21.2	4.42	.36	1.80	6.58	6.3	1.46	7.49	.68	9 63	9.0	8.95	----	7.65	7.65	7.5
40.34	21.5	7.10	----	1.57	8.67	9.0	----†	----	----	9.48	8.0	----	----	8.17	8.63	8 5
31.04	22.4	----	----	3.16	3.16	3.0	----†	----	----	15.97	16.0	----	----	13.30	13.30	12.5
34.82	23.5	----	1.20	3.64	4.84	4.1	4.56	2.94	1.02	8.52	8.0	7.50	5.5	.90	13.11	----
28.11	24.5	.88	.39	2.71	3.98	3.3	3.18	6.20	1.39	10.77	8.0	9.38	7.0	.37	6.79	6.0
22.40	25.0	.79	----	1.66	2.45	2.3	3.20	6.26	2.99	12.45	10.0	9.46	----	5.07	5.07	5.0
30.30	25.4	1.47	.22	3.65	5.34	5.0	1.23	7.87	1.77	10.87	10.0	9.10	7.0	.92	5.53	10 0
25.41	25.9	----	----	----	----	----	none	7.49	3.60	11.09	----	7.49	6.0	.44	16 52	15.0
29.99	26.7	.71	.17	2.82	3.70	3.5	1.66	7.38	1.59	10.63	9 0	9.04	----	.83	9.87	8.7
26.02	26.8	.04	.76	2.50	3.30	3.3	5.78	6.35	1.48	13.61	13.0	12.13	12.0	3.96	3 96	3.0
25.59	28.2	.63	.98	2.05	3.66	3.3	2.46	3.42	.53	6.41	6.0	5 88	4.0	1.09	9.21	8.0
28.06	28.3	.56	----	2.67	3.23	3.6	4.43	5.95	1.90	12.28	8.0	10.38	----	8.25	8.25	7.0

* Valuation exceeds cost. † Mixture of Bone and Chemicals.

SPECIAL MANURES, SAMPLED BY THE STATION.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
8263	Havana Tobacco Grower.	M. E. Wheeler & Co., Rutland, Vt.	G. W. Bancroft, East Windsor Hill.	**$31.00**
8024	Potato Manure.	Mapes F. & P. G. Co., New York.	J. M. Page & Co., Naugatuck.	42.00
			Mapes Branch, Hartford.	**37.00**
8267	Americus Fine Wrapper Tobacco.	Williams & Clark, New York.	I. J. Beardsley, New Preston.	**46.00**
8269	Tobacco Manure, Wrapper Brand.	Mapes F. & P. G. Co., New York.	Mapes Branch, Hartford.	**44.00**
8115	Stockbridge Grass Top Dressing and Forage Crop Manure.	Bowker Fertilizer Co., Boston, Mass.	C. W. Michaels & Co, Yalesville.	38.00
				40.00
			W. C. Pease, Somers.	**39.00**
8005	Grass and Grain Spring Top Dressing.	Mapes F. & P. G. Co., New York.	Mapes Branch, Hartford.	**38.00**
			J. H. Ray & Son, Greenwich.	40.00
6771	High Grade Soluble Tobacco Manure.	Rogers Manufacturing Co., Rockfall.	Manufacturer.	**43.00**
8171	Complete Potato Manure.	H. J. Baker & Bro., New York.	E. H. Talcott, Torrington.	38.00
			Strong & Tanner, Winsted.	35.00
				36.50
8004	Corn Manure.	Mapes F. & P. G. Co., New York.	J. H. Ray & Son, Greenwich.	36.00
			Mapes Branch, Hartford.	**34.00**
8287	Complete Manure.	Standard Fertilizer Co., Boston, Mass.	L. Mullaley, Windsor.	**35.00**
8026	Cereal Brand.	Mapes F. & P. G. Co., New York.	Mapes Branch, Hartford.	**26.00**
			C. W. Atwood, Watertown.	26.00
8208	Complete Tobacco Manure.	H. J. Baker & Bro., New York.	F. C. Bidwell, Windsor Locks.	**40.00**
8020	Vegetable, Vine and Tobacco.	Great Eastern Fertilizer Co., Rutland, Vt.	Chas. W. Atwood, Watertown.	26.00
				32 00
			Silas Finch, Greenwich.	**29.00**
8146	Tobacco Starter.	Mapes F. & P. G. Co., New York.	M. D. Murphy, Windsor.	35.00
			Mapes Branch, Hartford.	**33.00**
8214	Stockbridge Special Tobacco Manure.	Bowker Fertilizer Co., Boston, Mass.	George M. Risley, Windsor.	**47.00**
8023	Stockbridge Potato and Vegetable Manure.	Bowker Fertilizer Co., Boston, Mass.	C. T. Leonard, Norwalk.	40.00
			D. B. Wilson, Waterbury,	35.00
				37.50
8315	Fruit and Vine Manure.	Mapes F. & P. G. Co., New York.	Mapes Branch, Hartford.	**37.00**
8232	Wheeler's Fruit Fertilizer.	M. E. Wheeler, Rutland, Vt.	F. C. Latimer, New Britain.	**27.00**
			G. W. Bancroft, E. Windsor Hill.	----
8157	Tobacco Ash Constituents.	Mapes F. & P. G. Co., New York.	George M. Risley, Windsor.	30.00
			Mapes Branch, Hartford.	30.00
			W. W. Cooper, Suffield.	**30.00**
8116	Tobacco Starter.	Bowker Fertilizer Co., Boston, Mass.	E. F. Miller, Ellington.	33.00
			H. K. Brainard, Thompsonville.	35.00
				34.00

ANALYSES.—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
$24.02	29.1	....	....	3.71	3.71	*2.9*	2.99	4.34	1.37	8.70	....	7.33	*6.0*	.73	5.52	*7.0*
28.58	29.5	1.16	.70	2.12	3.98	*3.7*	4.74	4.62	.75	10.11	*8.0*	9.36	*8.0*	.52	7.42	*6.0*
35.06	31.2	....	3.10	3.10	6.20	*5.8*	3.97	2.08	1.50	7.55	*6.0*	6.05	*6.0*	.88	11.05	*10.0*
33.49	31.4	1.43	2.34	2.21	5.98	*6.1*	0.32	4.39	.80	5.51	*4.5*	4.71	....	1.13	12.03	*10.5*
29.67	31.5	3.09	....	2.05	5.14	*5.0*	5.79	2.30	1.10	9.19	*6.0*	8.09	....	6.86	6.86	*6.0*
28.55	33.1	1.36	1.66	2.23	5.25	*4.9*	4.61	2.28	.26	7.15	*6.0*	6.89	*5.0*	7.30	7.30	*7.0*
32.17	33.6	1.40	....	2.93	4.33	*5.0*	1.95	5.21	.86	8.02	*8.0*	7.16	....	1.13	12.46	*11.0*
27.25	33.9	.41	1.32	2.05	3.78	*3.3*	5.34	1.17	.58	7.09	*6.8*	6.51	*5.8*	4.14	9.94	*10.0*
25.37	34.0	.52	.84	1.44	2.80	*2.5*	7.36	3.41	.50	11.27	*10.0*	10.77	*8.0*	6.56	6.56	*6.0*
26.01	34.6	.39	.81	2.39	3.59	*3.3*	5.39	3.50	1.23	10.12	*9.0*	8.89	*8.0*	6.80	6.80	*7.0*
19.19	35.5	....	....	2.26	2.26	*1.6*	6.18	2.99	.37	9.54	*8.0*	9.17	*6.0*	3.26	3.26	*3.0*
29.52	35.5	....	3.22	1.84	5.06	*4.5*	4.08	.83	.26	5.17	....	4.91	*4.0*	.86	10.35	*10.0*
21.27	36.3	....	....	2.18	2.18	*2.0*	6.40	2.04	1.10	9.54	....	8.44	*8.0*	6.28	6.28	*6.0*
24.15	36.6	1.11	.62	1.21	2.94	*2.5*	7.70	3.73	1.49	12.92	*12.0*	11.43	*8.0*	....	3.18	*2.5*
34.16	37.6	2.78	....	3.32	6.10	*5.5*	2.46	3.27	3.14	8.87	*6.0*	5.73	*4.0*	.16	9.86	*10.0*
27.19	37.9	1.14	....	2.22	3.36	*3.2*	5.18	2.40	.90	8.48	*7.0*	7.58	*5.0*	10.35	10.35	*10.0*
26.63	38.9	.34	.28	1.54	2.16	*1.7*	4.32	3.07	.50	7.89	*7.0*	7.39	*5.0*	.78	12.67	....
19.16	40.9	....	....	....	....	....	6.48	4.40	1.35	12.23	....	10.88	*10.0*	7.45	7.83	*8.0*
21.11	42.1	....	....	.67	.67	*0.5*	none	2.43	3.70	6.13	*5.7*	2.43	....	.77	15.40	*15.0*
23.69	43.5	.61	....	2.06	2.67	*2.3*	5.82	4.55	2.27	12.64	*12.0*	10.37	*8.0*	.77	4.43	*3.0*

SPECIAL MANURES, SAMPLED BY THE STATION.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
8752	Sweepstakes Potato Manure.	Clark's Cove Fertilizer Co., New York.	Henry Fields, Newington.	**$36.00**
8172	Special Potato Manure.	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Bronson Brothers & Co., Winchester Center.	**37.00**
			E. H. Talcott, Torrington.	38.00
8811	New England Tobacco and Potato Grower.	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	H. E. Kelsey, Westbrook.	35.00
8021	New England Tobacco and Potato Grower.	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Meeker Coal Co , Norwalk.	34.00
			O. H. Meeker, Danbury.	33.00
8285	Onion Manure.	Quinnipiac Co., Boston, Mass.	W. C. Pease, Somers.	**38.00**
8012	Potato Phosphate.	National Fertilizer Co., Bridgeport.	Manufacturer.	33.00
			J. F. Buckhout, Greenwich.	**32.00**
8289	Americus High Grade Special.	Williams & Clark, New York.	Greenwood Co., New Hartford.	**38.00**
8301	Potato Manure.	Packer's Union Fertilizer Co., New York.	Rockville Milling Co., Rockville.	**32.00**
8325	Animal Corn Fertilizer.	Packer's Union Fertilizer Co., New York.	Rockville Milling Co., Rockville.	**30.00**
8746	Complete Manure for Potatoes and Vegetables.	Bradley Fertilizer Co., Boston, Mass.	E. N. Pierce & Co., Plainville.	**39.00**
			R. W. Keeler, N. Wilton.	40.00
8070	Complete Manure for Potatoes and Vegetables.	Bradley Fertilizer Co., Boston, Mass.	J. A. Lewis, Willimantic.	----
			S. A. Billings, Meriden.	----
8010	Vegetable, Vine and Potato Manure.	H. J. Baker & Bro., New York.	Henry Lockwood, Stamford.	**35.00**
			R. & D. Loudon Bros., Winnipauk.	35.00
8319	Americus Corn Phosphate.	Williams & Clark, New York.	George H. Sloan, Windsorville.	**31.00**
8209	Complete Manure for Top Dressing Grass and Grain.	Bradley Fertilizer Co., Boston, Mass.	D. W. Spencer, Centerbrook.	**36.00**
8071	Potato, Hop and Tobacco Phosphate.	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Edward Davis & Son, Danielson.	**33.00**
				36.00
			J. E. Leonard & Son. Jewett City.	30.00
8293	Special Potato Fertilizer.	Henry F. Tucker, Boston, Mass.	E. W. Buck & Co., Willimantic.	**33.00**
8749	High Grade Potato Fertilizer.	E. Frank Coe Co., New York.	C. D. Way, Gilead.	**35.00**
8073	High Grade Potato Fertilizer.	E. Frank Coe Co., New York.	H. B. Sherwood, Southport.	32.00
			J. O. Fox & Co., Putnam.	38.00
8086	Americus Potato and Tobacco Fertilizer.	Williams & Clark, New York.	F. C. Benjamin & Co., Danbury.	30.00
				35.00
			G. F. Day, South Manchester.	**32.50**
8322	Grass Manure.	Williams & Clark Fertilizer Co , New York.	J. H. Avery, Lebanon.	**32.00**
8072	Stockbridge Special Corn Manure.	Bowker Fertilizer Co., Boston, Mass.	J. A. Lewis, Willimantic.	**40.00**
			Jas. A. Nichols, Danielson.	39.00
			C. T. Leonard, Norwalk.	40.00

ANALYSES—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		Available.		Found.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
$25.03	43.8	....	.74	2.42	3.16	*2.9*	4.99	3.63	1.23	9.85	*8.0*	8.62	*7.0*	7.39	7.39	*7.5*
25.60	44.5	....	....	3.80	3.80	*3.7*	6.29	2.07	1.29	9.65	....	8.36	*8.0*	6.06	6.06	*5.4*
24.17	44.8	....	....	3.66	3.66	*3.3*	3.68	1.71	1.68	7.07	...	5.39	*6.0*	.68	7.56	*5.4*
*	....	....	....	3.10	3.10	*3.3*	5.79	1.93	2.14	9.86	....	7.72	*6 0*	.80	5.18	*5.4*
26.13	45.4	....	.96	2.48	3.44	*3.3*	5.50	3.58	1.33	10.41	*9.0*	9.08	*9.0*	7.16	7.16	*7.0*
21.99	45.5	....	....	2.22	2.22	*2.0*	3.09	3.76	1.80	8 65	*8.0*	6.85	*6.0*	8.10	8.71	*8.0*
26.00	46.2	...	.96	2.50	3.46	*3.7*	4.64	4.13	1.98	10.75	*8.0*	8.77	*7.0*	7.10	7.10	*7.0*
21.72	47.3	....	....	2.34	2.34	*2.0*	6.10	2.25	1.37	9.72	....	8.35	*8.0*	6.29	6.29	*6.0*
20 15	48.9	.08	.34	2.18	2.60	*2.5*	7.14	2.24	1.07	10.45	....	9.38	*8.0*	2.65	2.65	*2.0*
26.15	49.1	.56	.53	2.63	3.72	*3.7*	5:25	4.40	1.30	10.95	*9.0*	9.65	*8.0*	5.66	5.66	*6.0*
*	....	1.20	....	2.40	3.60	*3.7*	4.51	4.73	1.85	11.09	*9.0*	9.24	*8.0*	5.32	5.32	*6.0*
23.36	49.8	....	.76	1.28	2.04	*1.7*	5.78	.62	.32	6.72	*6.5*	6.40	*5.5*	11.37	11.76	*12.0*
20.60	50.5	....	....	2.24	2.24	*2.0*	6.72	2.99	2.30	12.01	*10.0*	9.71	*9.0*	3.37	3.37	*1.5*
23.70	51.9	5.29	....	....	5.29	*5.0*	1.86	3.82	1.16	6.84	*6.0*	5.68	*5.0*	.73	2.63	*2.5*
21.59	52.8	....	....	2.32	2.32	*2.0*	8.59	2.33	.56	11.48	...	10.92	*10.0*	3.43	3.43	*3.3*
21 58	52.9	.47	....	2.17	2.64	*2.4*	2.61	4.74	2.31	9.66	*9.0*	7.35	*8.0*	6.28	6.28	*6.0*
22.88	52.9	....	.71	1.82	2.53	*2.4*	6.51	1.96	1.41	9.88	*9.0*	8.47	*8.0*	.58	6.24	*6.0*
*	....	....	.67	1.83	2.50	*2.4*	6 82	2.49	2.43	11.74	*9.0*	9.31	*8.0*	.34	4.97	*6.0*
21.20	53.3	....	.15	2.40	2.55	*2.0*	5.02	4.28	2.87	12.17	*9.0*	9.30	*8.0*	3.47	3.47	*3.0*
20.72	54.4	3.97	....	.35	4.32	*3.9*	1.76	3.90	1.24	6.90	*6.0*	5.66	*5.0*	.57	2.34	*2.0*
25.83	54.9	1.02	....	2.20	3.22	*3.0*	6.37	2.42	1.28	10.07	*10.0*	8.79	*7.0*	7.63	7.63	*6.0*

* Valuation not given for reasons stated on p. 122.

SPECIAL MANURES, SAMPLED BY THE STATION.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
8230	Tobacco Manure.	Lowell Fertilizer Co., Boston, Mass.	Edward White, Rockville. G. W. Bancroft, East Windsor Hill.	$50.00 45.00 **47.50**
8308	Northern Corn Special.	Great Eastern Fertilizer Co., Rutland, Vt.	W. D. Wanzer, Lanesville.	**32.00**
8067	High Grade Potato Manure.	M. E. Wheeler & Co., Rutland, Vt.	W. C. Pease, Somers. Dwight Gallup, Old Mystic.	32.00 30.00 **31.00**
8318	Potato Fertilizer.	Cumberland Bone Phosphate Co., Boston, Mass.	William Bartell, Ore Hill.	**31.00**
8079	Potato Phosphate.	Quinnipiac Co., Boston, Mass.	C. A. Young, Danielson. Bailey & Markham, Cobalt.	30.00 33.00 **31.50**
8327	Potato and Vegetable Manure.	Bowker Fertilizer Co., Boston, Mass.	James M. Young, Norwich. D. B. Wilson & Co., Waterbury.	**28.00** ---- ----
8093	Potato, Hop and Tobacco Phosphate.	Milsom Rendering and Fertilizer Co., East Buffalo, New York.	W. C. Pease, Somers. Lyman Bros., Columbia.	35.00 33.00 **34 00**
8088	Potato Fertilizer.	Bradley Fertilizer Co., Boston. Mass.	C. H. Baker, Andover. S. A. Billings, Meriden.	35.00 30.00 **32.50**
8102	Read's Vegetable and Vine.	Read Fertilizer Co., New York.	E. E. Pitney, Ellington. L. D. Post, Andover.	**34.00**
8154	Special Potato Manure.	Pacific Guano Co., Boston, Mass.	T. B. Wickwire, Berlin. John O. Fox & Co., Putnam.	33.00 **32.00**
8294	Potato and Tobacco Fertilizer.	Standard Fertilizer Co., Boston. Mass.	Jacob Glover & Son, Stafford.	**33.00**
8302	Swift's Lowell Potato Phosphate.	Lowell Fertilizer Co., Boston, Mass.	W. D. Penfield, Cobalt.	**37.00**
8174	Grain Grower.	Armour Fertilizer Co., Chicago, Ill.	E. A. Buck & Co., Willimantic.	**30.00**
8069	High Grade Corn Fertilizer.	M. E. Wheeler & Co., Rutland, Vt.	W. C. Pease, Somers. Dwight Gallup, Old Mystic.	30.00 28.00 **29.00**
8747	Americus Potato Phosphate.	Williams & Clark Fertilizer Co., New York.	F. B. Austin, Silver Mine. J. H. Avery, Lebanon.	**33.00** ----
8103	Americus Potato Phosphate.	Williams & Clark Fertilizer Co., New York.	W. B. Martin, Rockville. D. B. Wilson & Co., Waterbury.	35.00 33.00
8066	Corn Manure.	Quinnipiac Co., Boston, Mass.	W. C. Pease, Somers. C. A. Young, Danielson.	33.00 30.00 **31.50**
8014	Potato Manure.	Quinnipiac Co., Boston, Mass.	Olds & Whipple, Hartford. Adams & Canfield, Winnipauk.	35.00 32.00 **33.50**
8166	Corn Phosphate.	Bowker Fertilizer Co., Boston, Mass.	Balch & Platt, West Winsted. J. A. Lewis, Willimantic.	33 00 32.00 **30.00**
8751	Potato Phosphate.	Clark's Cove Fertilizer Co., New York.	Henry Fields, Newington.	**33.00**

ANALYSES—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
$30.60	55.2	....	3.38	2.17	5.55	*4.9*	3.62	2.91	.26	6.79	*7.0*	6.53	*6.0*	1.05	8.50	*8.0*
20.60	55.3	....	.26	2.68	2.94	*2.9*	7.33	1.78	1.01	10.12	....	9.11	*8.0*	2.40	2.40	*2.0*
19.90	55.8	....	....	2.39	2.39	*2.1*	6.37	2.80	1.28	10.45	....	9.17	*8.0*	3.21	3.21	*3.2*
19.89	55.9	.44	....	1.82	2.26	*2.1*	4.86	4.98	1.70	11.54	*11.0*	9.84	*9.0*	2.83	2.83	*3.0*
20.16	56.2	....	....	2.22	2.22	*2.0*	5.66	3.54	2.48	11.68	*9.0*	9.20	*8.0*	3.53	3.53	*3.0*
17.82	57.1	.62	....	1.27	1.89	*1.5*	3.87	4.96	3.32	12.15	*10.0*	8.83	*8.0*	2.19	2.19	*2.0*
21.56	57.7	....	....	1.80	1.80	*1.6*	6.43	1.36	.75	8.54	*10.0*	7.79	*8.0*	8.65	8.65	*8.0*
20.56	58.0	....	....	2.46	2.46	*2.0*	5.62	3.88	2.53	11.53	*11.0*	9.00	*9.0*	3.44	3.44	*3.3*
21.44	58.5	.04	....	2.08	2.12	*1.7*	5.15	2.07	1.25	8.47	*7.0*	7.22	*6.0*	8.08	8.08	*8.0*
20.17	58.7	....	.24	2.50	2.74	*2.5*	3.01	3.33	3.22	9.56	*7.0*	6.34	*5.0*	5.10	5.10	*5.0*
20.71	59.3	....	....	2.40	2.40	*2.1*	5.23	4.30	2.84	12.37	*9.0*	9.53	*8.0*	3.11	3.11	*3.0*
23.08	60.3	....	....	2.60	2.60	*2.5*	6.06	4.05	.89	11.00	....	10.11	*8.0*	1.33	4.85	*6.0*
18.72	60.3	....	....	2.16	2.16	*1.6*	3.81	4.73	4.34	12.88	*10.0*	8.54	*8.0*	2.03	2.21	*2.0*
18.03	60.6	....	....	1.89	1.89	*1.6*	6.69	2.63	1.12	10.44	....	9.32	*8.0*	2.55	2.55	*2.0*
20.48	61.1	....	....	2.75	2.75	*2.5*	3.26	3.44	2.26	8.96	*7.0*	6.70	*6.0*	5.39	5.39	*5.0*
*	....	.17	.30	1.81	2.28	*2.5*	3.09	4.58	2.53	10.20	*7.0*	7.67	*6.0*	3.94	3.94	*5.0*
19.36	62.7	....	....	2.35	2.35	*2.1*	5.71	4.01	2.22	11.94	*10.0*	9.72	*9.0*	1.78	1.78	*1.5*
20.48	63.5	....	.18	2.40	2.58	*2.0*	2.34	4.06	2.48	8.88	*7.0*	6.40	*6.0*	6.28	6.28	*5.0*
18.32	63.8	.62	....	1.31	1.93	*1.5*	5.68	3.48	2.74	11.90	*11.0*	9.16	*9.0*	2.31	2.31	*2.0*
19.91	65.7	....	.55	2.23	2.78	*2.5*	1.90	4.33	3.03	9.26	*9.0*	6.23	*6.0*	5.05	5.05	*5.0*

* Valuation not given for reasons stated on p. 123.

SPECIAL MANURES, SAMPLED BY THE STATION.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
8009	Potato Manure.	Bradley Fertilizer Co., Boston, Mass.	E. E. Scoville. Stamford.	$35.00
			Raymond Bros., S. Norwalk	**31.00**
			S. A. Billings. Meriden.	33.00
			Wheeler & Howes, Bridgeport.	35.00
8213	Corn Phosphate.	Bradley Fertilizer Co., Boston, Mass.	D. T. Dyer, Collinsville.	**33.00**
8150	Wheat, Oats and Barley Phosphate.	Milsom Rendering and Fertilizer Co., East Buffalo, N. Y.	Lyman Bros., Columbia.	27.00
			J. C. Lincoln, Berlin.	**26.00**
8090	Practical Potato Special.	Read Fertilizer Co., New York.	L. D. Post, Andover.	....
			John R. Babcock, Mystic.	**28.00**
8232	Wheat, Oats and Clover.	Packers Union Fertilizer Co., New York.	Rockville Milling Co., Rockville.	**25.00**
8147	Ammoniated Wheat and Corn Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	M. D. Stanley, New Britain.	32 00
			W. A. Thrall, Windsor.	35.00
				33.00
8314	Grass Fertilizer.	Quinnipiac Co., Boston., Mass.	W. C. Pease, Somers.	**35.00**
8199	High Grade Grass and Oats.	M. E. Wheeler & Co., Rutland, Vt.	W. C. Buckley, Forestville.	26.00
			C. I. Harvey & Son, Middletown.	24.00
				25.00
8196	Potato, Tobacco and Hop Fertilizer.	Niagara Fertilizer Co., Buffalo, N. Y.	H. C. Porter, Hebron.	33.00
			J. H. Day, Jr., Old Saybrook.	28.00
				32.00
			J. W. Enerle, Stratford.	**31.00**
8152	Corn Fertilizer.	Milsom Rendering and Fertilizer Co., East Buffalo, N. Y.	G. W. Barnes, Windsor.	33.00
			W. C. Pease, Somers.	30.00
				31.50
8317	Potato and Tobacco Fertilizer.	Clark's Cove Fertilizer Co., New York.	James M. Burk, South Manchester.	**37.00**
8077	Potato, Hop and Tobacco Phosphate.	Milsom Rendering and Fertilizer Co., East Buffalo, N. Y.	W C. Pease, Somers.	**33.00**
			J. R. Gilbert, Gilead.	32 50
8078	Universal Grain Grower.	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	O. H. Meeker, Danbury.	26.00
			Henry Davis, Durham Center.	28.00
				27.00
8098	Wheat and Corn Producer.	Niagara Fertilizer Co., Buffalo, N. Y.	H. C. Porter, Hebron.	30.00
			C. F. Tallard & Son, Broadbrook.	**28.00**
8328	Grass and Grain Fertilizer.	Pacific Guano Co., Boston, Mass.	John O. Fox & Co., Putnam.	**28.00**
8087	Grain and Grass Grower.	Niagara Fertilizer Co., Buffalo, N. Y.	H. C. Porter, Hebron.	28.00
			Stiant Bros., Manchester.	26.00
				27.00

ANALYSES—*Concluded.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		Available.		Found.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
$20.40	66.7	.04	....	2.67	2.71	*2.5*	4.75	2.23	1.63	8.61	*8.0*	6.98	*6.0*	5.22	5.22	*5.0*
19.76	67.0	....	....	2.35	2.35	*2.1*	6.00	4.14	2.08	12.22	*10.0*	10.14	*9.0*	1.79	1.79	*1.5*
15.43	68.5	....	....	1.25	1.25	*1.2*	6.40	2.37	2.14	10.91	*9.0*	8.77	....	.99	1.76	*2.0*
16.39	70.8	.09	....	1.07	1.16	*0.8*	3.63	1.47	.84	5.94	....	5.10	*4.0*	8.16	8.16	*8.0*
14.53	72.0	....	....	....	....	....	4.56	6.73	2.22	13.51	....	11.29	*11.0*	2.10	2.10	*3.5*
18.97	73.9	....	....	2.03	2.03	*2.0*	8.27	2.29	.80	11.36	....	10.56	*10.0*	1.76	1.76	*1.60*
20.03	74.7	....	4.24	.31	4.55	*3.9*	3.42	1.56	.66	5.64	*6.0*	4.98	*5.0*	2.37	2.37	*2.0*
14.28	75.0	....	....	....	....	....	7.15	3.94	1.64	12.73	....	11.09	*11.0*	2.01	2.01	*2.0*
17.68	75.2	....	....	1.92	1.92	*1.8*	6.46	2.14	.74	9.34	....	8.60	*8.0*	3.06	3.06	*2.7*
17.83	76.8	....	....	2.46	2.46	*2.5*	5.68	1.98	1.64	9.30	*9.0*	7.66	*8.0*	2.13	2.26	*2.0*
20.76	78.2	....	....	2.28	2.28	*2.1*	5.98	3.63	2.30	11.91	*9.0*	9.61	*9.0*	3.61	3.61	*3.0*
18.23	81.0	....	....	1.96	1.96	*2.1*	6.40	2.02	1.28	9.70	*9.0*	8.42	*8.0*	3.52	3.52	*4.0*
14.79	82.5	....	....	1.26	1.26	*0.8*	5.18	1.78	2.20	9.16	....	6.96	*7.0*	3.22	3.22	*2.7*
14.90	87.9	....	....	1.47	1.47	*1.2*	5.71	2.34	.52	8.57	...	8.05	*8.0*	2.17	2.17	*2.2*
14.60	91.8	....	....	1.15	1.15	*0.8*	5.18	2.89	1.51	9.58	*8.0*	7.07	*7.0*	2.43	2.43	*1.0*
11.96	125.7	....	....	.98	.98	*0.8*	4.30	3.12	.78	8.20	*8.0*	7.42	....	1.18	1.18	*1.0*

ANALYSES OF FERTILIZERS SPECIALLY NOTICED ON PAGES 122 AND 123.

	Bradley's Complete for Potatoes and Vegetables.			Coe's High Grade Potato Fertilizer.			Americus Potato Phosphate.			Crocker's New England Tobacco and Potato Grower.		
	8070	**8746**	*Guarantee.*	**8078**	**8749**	*Guarantee.*	**8103**	**8747**	*Guarantee.*	**8021**	**8811**	*Guarantee.*
Nitrogen as Nitrates	1.20	0.56		....	....		.17	....		....	....	
" Ammonia	....	0.53		0.67	.71		.30	....		....	....	
" Organic	2.40	2.63		1.83	1.82		1.81	2.75		3.10	3.66	
" Total	3.60	3.72	*3.7*	2.50	2.53	*2.4*	2.28	2.75	*2.5*	3.10	3.66	*3.3*
Phosphoric Acid, Soluble	4.51	5.25	*8.0*	6.82	6.51	*8.0*	3.09	3.26	*6.0*	5.79	3.68	*6.0*
" Reverted	4.73	4.40		2.49	1.96		4.58	3.44		1.93	1.71	
" Insoluble	1.83	1.30		2.43	1.41		2.53	2.26		2.14	1.68	
" Total	11.09	10.95	*9.0*	11.74	9.88	*9.0*	10.20	8.96	*7.0*	9.86	7.07	....
Potash as Muriate	5.32	5.66		0.34	0.58		3.94	5.39		.80	.68	
" Sulphate	....	....		4.60	5.66		....	....		4.38	6.88	
" Total	5.32	5.66	*6.0*	4.94	6.24	*6.0*	3.94	5.39	*5.0*	5.18	7.56	*5.4*
Cost	$38.50	39.00		35.00	35 00		34.00	33.00		34.00	35,00	
Valuation	$25.30	26.15		22.80	22.88		18.90	20.48		22.94	24.17	

Attention is also called to various discrepancies between the analysis and the manufacturer's guarantee which are noticeable in goods consisting of mixtures of ground bone and chemicals. As illustrations we cite the following :

		Nitrogen.		Phosphoric Acid.		Potash.	
		Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
8316	Mapes' Seeding Down Manure	2.6	2.5	17.2	18.0	12.6	10.0
4761	Hubbard's Corn and General Crop......	5.2	5.5	11.2	12.0	17.1	12.0
4764	Hubbard's Grass and Grain Manure.....	3.1	2.5	17.9	16.5	11.7	12.5
4763	Hubbard's Oats and Top-Dressing	8.7	9.0	9.5	8.0	8.6	8.5

It is seen that in every case a deficiency in one ingredient is offset by a decided excess over the guarantee in case of another ingredient.

These inequalities are due to the nature of the materials used. It is extremely difficult to uniformly mix dry bone—or some kinds of blood tankage—with fertilizer chemicals, and when once mixed the slight jarring, incident to storage and transportation, is sufficient to cause considerable mechanical separation of the particles of bone or tankage from the chemicals. Even when a small sample has been very finely pulverized for analysis great care is necessary to avoid this separation of the different ingredients.

2 *and* 3. *Sampled by Manufacturers and Purchasers.*

In a following table are eight analyses belonging in these classes. To comply with the Fertilizer Law of Connecticut, the Station analyzes samples supplied by manufacturers or purchasers, when the Station agent fails to find the goods on sale by dealers.

SPECIAL MANURES, SAMPLED BY MANUFACTURERS

Station No.	Name or Brand.	Manufacturer.	Sampled by
6697	Boardman's Complete Fertilizer for Potatoes and General Crops.	F. E. Boardman, Westfield, Conn.	Manufacturer.
8338	Bradley's Potato Fertilizer.	Bradley Fertilizer Co., Boston, Mass.	Manufacturer.
8337	Lister's Special Potato Fertilizer.	Lister's Agricultural Chemical Works, Newark, N. J.	Manufacturer.
8336	Gold Edge Potato Manure.	Tygert-Allen Fertilizer Co., Philadelphia.	Manufacturer.
8335	Potato Special Fertilizer.	Walker, Stratman & Co, Pittsburgh, Pa.	Manufacturer.
8278	Mapes' Tobacco Starter.	Mapes' F. & P. G. Co., New York.	C. J. Dewey, Buckland.
8276	Sanderson's Potato Manure	L. Sanderson, New Haven.	C. J. Dewey, Buckland.
8237	Potato, Onion and Tobacco Manure.	Wilcox Fertilizer Works, Mystic.	M. E. Thompson, Ellington.

BOWKER'S BONE AND WOOD ASH FERTILIZER.

8027. Made by Bowker Fertilizer Co., Boston. Sampled from stock of D. B. Wilson & Co., Waterbury, by Station Agent. Claimed to be "made up of Canada hard wood ashes, to which is added pure dissolved bone and additional ammonia in chemical form."

ANALYSIS.

	8027
Nitrogen as nitrates	1.42
" organic	.67
" total	2.09
Phosphoric Acid, soluble	none
" " reverted	7.41
" " insoluble	4.99
" " total	12.40
Potash, as muriate	.33
" as sulphate and carbonate	1.58
" total	1.91
Cost	$25.00
Valuation	19 82

OR PURCHASERS. ANALYSES.

	Nitrogen.					Phosphoric Acid.							Potash.		
				Total Nitrogen.					Total.		Available.		Found.		
Valuation per Ton.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
$25.42	....	....	2.56	2.56	*2.4*	4.58	3 83	.33	8.74	....	8.41	*7.0*	10.28	10.28	*10.0*
20.73	....	.17	2.09	2.26	*2.1*	5.76	4.28	2.24	12.28	*11.0*	10.04	*9.0*	3.22	3.22	*3.2*
20.34	....	....	1.68	1.68	*1.6*	6.93	4.00	.81	11.74	....	10.93	*8.0*	1.94	3.89	*3.0*
22.14	....	....	2.46	2.46	*2.5*	5.92	2.35	1.29	9.56	....	8.27	*6.0*	6.52	6.52	*5.0*
22.55	....	....	2.04	2.04	*1.6*	8.00	2.23	1.00	11.23	*13 0*	10.23	*9.0*	.41	5.45	*5.0*
26.18	.87	1.84	.92	3.63	....	7.54	4.48	1.02	13.04	....	12.02	....	.72	3.08	....
26.65	.78	....	2.41	3.19	....	7.07	3.82	.73	11.62	....	10.89	....	5.61	6.39	....
28.36	.97	.20	2.81	3.98	....	3.18	6.35	1.43	10.96	....	9.53	....	.37	6.85	....

HOME MIXTURES.

In the following table are analyses of ten mixtures made by the persons named, for their own use. With the analyses are given the formulas by which they were compounded.

The cost price named does not include the cost of mixing, usually estimated at from one to two dollars per ton. If two dollars per ton were added to the cost of these mixtures, for mixing, their average cost per ton would be $29.16, and their average valuation $29.07.

HOME MIXTURES, FORMULAS (☞)

Station No.	Made by	Formulas, Pounds per Ton of Mixture.									
		Nitrate of Soda.	Cotton Seed Meal.	Dry Fish.	Tankage.	Fine Ground Bone.	Mapes' Dissolved Bone.	Dissolved Bone Black.	Acid Phosphate.	Muriate of Potash.	High Grade Sulphate of Potash.
6677	F. T. Bradley, Saybrook.	100	....	....	1500	....	...	....	....	400	....
6701	S. D. Woodruff & Sons, Orange.	200	....	....	800	....	....	....	700	300	....
6739	W. H. Olcott, So. Manchester.	....	1200	....	....	....	....	500	....	300	....
6784	J. Norris Barnes, Yalesville.	....	....	....	850	....	....	....	800	350	....
8017	A. C. Lake, Bethlehem.	125	....	....	1000	....	....	....	500	....	375
8055	G. B. Porter, Waterbury.	....	1100	....	....	....	500	....	....	....	400
8064	W. L. & S. T. Merwin, Milford.	200	....	700	....	100	....	700	....	300	....
8192	For Oats, Daniel Bros., Middletown.	667	....	....	....	1000	....	....	....	333	....
8193	For Corn, Daniel Bros., Middletown.	444	....	....	....	222	....	....	1112	222	....
8279	C. J. Dewey, Buckland.	....	....	....	....	1818	....	....	....	....	182

MISCELLANEOUS FERTILIZERS AND MANURES.

COTTON HULL ASHES.

In the tables on pages 140 to 143 are given analyses of 55 samples of this material which is extensively used as a source of potash for fertilizing tobacco lands in this State.

These analyses show the usual wide range of composition, especially as regards potash, the ingredient for which the ashes are bought.

The highest percentage of potash was 36.45, the lowest, 10.26, while the average percentage was 22.4, slightly lower than the average in the previous year (23.1).

Allowing 5½, 5 and 2 cents per pound respectively for water-soluble, citrate soluble and insoluble phosphoric acid, the water-soluble potash has cost from 5.1 to 17.6 cents per pound, or 7.9 cents per pound on the average.

The fact that several samples were sent to the Station from a single car-load, which contained a very low per cent. of potash, partly explains this high "average" cost of potash.

Samples of Cotton Hull Ashes requiring Special Notice.

8185. The analysis of this sample did not correspond with the guarantee (24 per cent. of potash), and Messrs. Olds & Whip-

ANALYSES AND VALUATIONS.

Analyses.									Cost (unmixed) and Valuation.	
Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Total Phosphoric Acid.	Potash.	Cost per Ton.	Valuation per Ton.
.80	....	4.03	4.83	....	....	....	11.53	9.32	....	$29.75
1.26	....	2.20	3.46	4.64	6.37	1.34	12.35	8.13	$25.00	29.02
....	....	4.52	4.52	3.31	2.55	.51	6.37	8.85	24.53	27.02
....	....	3.96	3.96	5.04	2.15	1.01	8.20	8.85	....	27.15
.90	....	3.35	4.25	3.26	3.97	.77	8.00	7.99	25.50	27.76
....	....	4.58	4.58	1.70	4.23	.42	6.35	6.14	28.25	25.23
1.45	.51	2.34	4.30	6.57	2.47	.75	9.79	7.40	30.00	28.65
4.62	....	2.64	7.26	....	....	....	10.97	9.24	36.00	36.94
3.11	....	.83	3.94	3.84	4.96	2.73	11.53	5.76	23.40	26.48
....	....	....	2.42	....	....	....	23.01	5.13	25.00	31.47

ples state that the shippers agreed to make good the deficiency of potash, which would make the retail price $30.00.

6574, 6647, 6679, 6681, 6686 and **8040.** These samples represent a car-lot which F. S. Bidwell, Windsor Locks, received from the south and sold to several parties under guarantee of "24 per cent. potash." The Station usually determines only the potash soluble in water, as that which is insoluble is certainly quite inferior in agricultural value. The water-soluble potash in these samples ranged from 15.36 to 17.74 per cent.

The *total* potash in sample **6574,** however, amounted to 23.12 per cent. This large proportion of potash in insoluble form may be caused by long-continued heating or exceptionally high temperature, in presence of sand, which yields insoluble silicates of potash (glass or slag).

Mr. Bidwell made a claim against the shippers because of the inferior quality of the ashes.

It is not possible to purchase ashes at the south and be sure that they are of average quality till the ashes are delivered in this State. They should be bought under guarantee of the percentage of *water-soluble* potash.

Sample **6522** was sent to the Station, with a certificate stating that it was cotton hull ashes, that the dealer was W. W. Cooper of Suffield, the price $40.00 per ton, sample drawn by T. B. Hathaway, Windsor Locks, in the presence of W. W. Cooper.

ANALYSES OF

Station No.	Dealer or Purchaser.	Sampled by
8257	Olds & Whipple, Hartford. (Car. No. 5216)	P. Gilligan, Windsor
8254	Olds & Whipple, Hartford. (Car No. 5216)	P. Gilligan. Windsor
6654	F. L. Worthy & Co., Mittineague, Mass.	D. L. Brockett, Suffield
6711	R. A. Parker, Warehouse Point	George Watson, Warehouse Point
6728	F. L. Worthy & Co., Mittineague, Mass.	D. L. Brockett, Suffield
6653	D. L. Brockett, Suffield	A. F. Austin, Suffield
6690	F. S. Bidwell, Windsor Locks	Thomas Fitzgerald, Windsor Locks
8161	Olds & Whipple, Hartford	F. A. Bidwell, Canton Center
6573	I. Luther Spencer, Suffield	James E. Perkins, Suffield
6727	F. L. Worthy & Co., Mittineague, Mass.	D. L. Brockett. Suffield
6713	I. Luther Spencer, Suffield	E. J. Sheldon, West Suffield
6785	Clinton Spencer, Suffield	F. A. Scott, Suffield
6679	F. S. Bidwell, Windsor Locks	John L. Firtion. Windsor Locks
6686	F. S. Bidwell, Windsor Locks	John Ahern, Windsor Locks
6548	I. L. Spencer, Suffield	C. M. Owen, West Suffield
6798	I. Luther Spencer, Suffield	H. S. Cowles, Suffield
8033	Olds & Whipple, Hartford	J. A. DuBon, Poquonock
8252	F. L. Worthy & Co., Mittineague, Mass.	D. L. Brockett, Suffield
6574	F. S. Bidwell, Windsor Locks	Charles A. Birge. Suffield
8040	F. S. Bidwell, Windsor Locks	Daniel I. King, Windsor Locks
6681	F. S. Bidwell, Windsor Locks	James Easterly, Windsor Locks
6647	F. S. Bidwell, Windsor Locks	M. Doughney, Windsor Locks
6687	J. E. Soper & Co., Boston. Mass.	Edward Austin, Suffield
6545	I. Luther Spencer. Suffield	H. H. Austin, Suffield
6555	W. W. Cooper. Suffield	O. C. Rose, West Suffield
8202	Olds & Whipple. Hartford	F. A. Hamilton. Warehouse Point
8160	F. S. Bidwell, Windsor Locks	George Rengermann, East Granby
8141	F. S. Bidwell, Windsor Locks	C. D. Cannon, Windsor Locks

After reporting the analysis, inquiry was made of Mr. Cooper regarding the sample, as the percentages of both potash and phosphoric acid found in it were abnormally small.

Mr. Cooper, through his attorney, replied as follows:

"The sample of cotton hull ashes came from my own make. Being desirous of testing for myself the value of cotton hull ashes, a friend sent me 23 bales of the hulls, a part of which I burned, being very careful that no foreign substance came in contact with the hulls or ashes, so I know they were the pure ashes. The sample sent you was from these burned hulls, which, according to your analysis, contains but 10.50 per cent. potash."

The analysis of these ashes not included in the Tables is given on the next page.

The "coal" in the analysis probably represents hulls which were not completely burned. More than half the weight of the sample consists of sand and soil, and as Mr. Cooper was very care-

COTTON HULL ASHES.—*See also pages 142 and 143.*

Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Potash Soluble in Water.	Cost per Ton.	*Valuation per Ton.	Potash Costs Cents per Pound.*
0.83	6.27	0.90	25.44	$45.00	$32.98	**7.4**
0.80	6.80	0.91	24.44	45.00	32.48	**7.6**
0.99	7.15	1.06	20.53	40.00	29.19	**7.6**
0.66	5.12	1.33	22.10	40.00	28.48	**7.6**
1.70	6.19	0.94	20.51	40.00	28.95	**7.7**
0.96	7.06	0.86	19.75	40.00	28.21	**7.9**
1.57	7.57	1.38	19.03	40.00	28.88	**7.9**
1.42	13.59	1.65	19.05	46.40	34.86	**8.0**
0.77	6.87	0.91	19.84	40.00	27.93	**8.0**
0.69	7.47	0.76	19.63	40.00	28.16	**8.0**
0.90	7.43	0.60	19.36	40.00	28.02	**8.1**
0.38	5.05	0.93	20.92	40.00	26.76	**8.2**
1.76	8.15	1.00	17.74	40.00	28.23	**8.3**
2.16	7.63	1.53	17.45	40.00	28.07	**8.4**
0.59	6.84	0.82	17.41	38.00	25.23	**8.6**
0.53	7.42	0.46	18.24	40.00	26.42	**8.7**
1.23	7.01	0.89	20.69	45.00	29.41	**8.8**
0.69	4.88	1.21	19.10	40.00	25.22	**8.9**
1.90	7.65	1.54	16.43	40.00	26.79	**9.0**
1.60	7.73	1.77	16.32	40.00	26.59	**9.1**
1.76	8.40	1.24	15.36	40.00	26.20	**9.5**
1.68	7.52	1.62	15.57	40.00	25.59	**9.6**
0.93	4.79	0.61	17.49	40.00	23.54	**9.7**
0.22	3.41	0.92	15.12	40.00	19.14	**11.9**
0.42	3.77	1.62	14.72	40.00	19.60	**11.9**
0.43	3.63	1.34	15.68	45.00	20.32	**12.9**
....	3.55	0.76	10.28	40.00	14.13	**17.6**
....	3.56	0.84	10.26	40.00	14.16	**17.6**

ANALYSIS OF COTTON HULL ASHES.

	6522
Water-soluble Phosphoric Acid	trace
Citrate-soluble " "	1.48
Insoluble " "	.07
Potash, soluble in water	10.50
Sand and soil	51.50
Coal	17.87

ful that no foreign substance came in contact with the ashes, the hulls which he received must have been rather heavily freighted with sand.

The average amount of sand, soil and charcoal found in cotton hull ashes, as shown in the statement on page 144, is 14.04 per cent. The sample from Mr. Cooper contained 69.37 per cent.

* Reckoning water-soluble, citrate-soluble and insoluble phosphoric acid at 5½, 5 and 2 cents, respectively.

ANALYSES OF

Station No.	Dealer or Purchaser.	Sampled by
8112	E. A. Halliday, Suffield	Station Agent
8107	F. S. Bidwell, Windsor Locks	H. S Cowles, Suffield
6650	I. Luther Spencer, Suffield	O. W. Kellogg, Suffield
6537	Olds & Whipple, Hartford	John DuBon, Poquonock
8253	Olds & Whipple, Hartford. (236 sacks)	Frank S. Taylor, Hartford
8110	George A. Douglass, Thompsonville.	Charles T. Remington, Thompsonville.
6797	Francis Granger, East Granby	Virgil E. Viets, Copperhill
6652	Olds & Whipple, Hartford. Car No. 68303	Everett P. Brewer, Silver Lane
6536	Olds & Whipple, Hartford. Lippmann & McCallum, N. Y.	E. J. Brewer, Silver Lane
6535	Olds & Whipple, Hartford. C. H. Lippmann, New Orleans	T. P. Kinney, Windsor
6572	I. Luther Spencer, Suffield	E. S. Seymour, Windsor Locks
8035	G. A. Douglass, Thompsonville	C. D. Woodworth, Thompsonville
6549	Arkansas Cotton Oil Co., Helena, Ark.	C. M. Owen, West Suffield
6560	Olds & Whipple, Hartford	Olin Wheeler, Buckland
6534	J. E. Soper & Co., Boston	F. S. Taylor, Hartford
8018	Charles L. Spencer, Suffield	E. A. Russell, Suffield
6789	Olds & Whipple, Hartford	Frank S. Taylor, Hartford
8184	Olds & Whipple, Hartford. (165 bags)	Olin Wheeler, Buckland
6540	Olds & Whipple, Hartford. (C. H. Lippmann, New York)	John A. DuBon, Poquonock
6516	Olds & Whipple, Hartford. (C. H. Lippmann, New York)	E. P. Brewer, Silver Lane
6521		Frank Roberts, Silver Lane
6651	Olds & Whipple, Hartford. (Car No. 73192)	Everett P. Brewer, Silver Lane
8256	Olds & Whipple, Hartford. (Car No. 10517)	J. C. Fuller, Poquonock
8138	Charles L. Spencer, Suffield	Howard D. Sikes, Suffield
8185	Olds & Whipple, Hartford	Olin Wheeler, Buckland
8255	Olds & Whipple, Hartford. (Car No. 6246)	T. P. Kinney, Windsor
8019	Olds & Whipple, Hartford	A. E. Holcomb, Poquonock

Sample No. **8112** contained a higher percentage of potash, 36.76, than had previously been found in any cotton hull ashes analyzed at this Station. A complete analysis of these ashes is given on page 144. For comparison is also given an analysis of the ash of clean cotton hulls, prepared in the laboratory of the North Carolina Station and containing none of the sand or other impurities which cannot be excluded when hulls are burned on a large scale as fuel for steam boilers. In addition is given the average composition of cotton hull ashes as they are found in market, calculated from the results of 185 analyses.

COTTON HULL ASHES.—*See also pages 140 and 141.*

Water-soluble Phosphoric Acid.	Citrate Soluble Phosphoric Acid.	Insoluble Phosphoric Acid.	Potash Soluble in Water.	Cost per Ton.	Valuation per Ton.	Potash Costs Cents per Pound.*
....	3.00	0 10	36.45	$40.00	$39 49	**5.1**
1.65	7.38	1.23	28.99	40.00	38.68	**5.2**
1.66	8.52	0.50	27.45	40.00	38.00	**5.4**
2.54	7.78	0.29	31 75	45.00	42.44	**5.4**
2.37	7.98	0.65	31.25	45.00	42.10	**5.5**
0.75	7.27	0.77	26.08	37.00	34.49	**5.5**
1.12	7.34	0.34	30.34	42.00	39.05	**5.5**
2.32	7.38	0.47	32.00	45.00	42.12	**5.5**
2.67	7.74	0.45	31.13	45.00	41.99	**5.5**
3.63	8.56	0.51	28.26	45.00	41.01	**5.7**
1.33	8.01	0.98	25.96	40.00	35.82	**5.8**
0.69	7.47	0.85	24.60	37.00	33.17	**5.8**
0.86	7.41	0 76	23.92	38.00	32.57	**6.1**
1.63	6.25	0.63	30.07	45.00	38.36	**6.1**
4.16	9.17	0.84	25.52	45.00	39 61	**6.1**
0 88	7 92	0.50	25.10	40.00	34.19	**6.1**
1.95	8.00	0.46	27.02	45 00	37.35	**6.4**
0.06	8.80	0.71	23.64	40.00	32.79	**6.5**
3.68	8.09	0.96	24.56	45.00	37.08	**6.6**
0 77	7.33	0.41	25.16	42.00	33.50	**6.7**
0.82	7.23	0.32	25 11	42.00	33.37	**6.7**
1.70	7 84	0.81	25.20	45.00	35 23	**6.9**
0.80	7.95	0.72	25.59	45.00	34.71	**7.0**
0.62	6.53	1.69	22.48	40.00	30.37	**7.1**
0.52	4.25	1.50	17.05	30.00†	22 47	**7.2**
3.18	•6.69	1.04	23.48	45.00	34.09	**7.3**
0.96	8.80	1.00	23 92	45.00	34 18	**7.3**

It is clear that the high percentage of potash in 8112 was not caused by mixing a high grade potash salt with the ashes, as it is claimed is sometimes done, for the sample contains no considerably larger quantity of either sulphuric, or carbonic acids or chlorine than the strictly pure ashes. The only marked difference between the two is in the relative amount of lime and magnesia present.

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* Reckoning water-soluble, citrate-soluble and insoluble phosphoric acids at 5½, 5 and 2 cents respectively.

ANALYSES OF COTTON HULL ASHES.

	Ash of Pure Hulls.*	Commercial Cotton Hull Ash.	Average Composition (185 Analyses).§
		8112	
Water	....	5.95	9.00
Coal,	7.56	1.86	14.04
Sand and soil		6.16	
Silica	1.21	1.00	
Oxide of Iron and Alumina	1.69	.54	2.07
Lime	5.29	15.68	8.85
Magnesia	11.29	3.47	9.97
Potash	42.13	36.76	23.40
Soda	3.35†	1.18	2.58
Sulphuric Acid	3.04	1.92	2.56
Carbonic Acid	20.10	22.22	
Phosphoric Acid	2.96	3.10	9.08
Chlorine	1.74	1.40	1.60
	100.36	101.24	
Deduct oxygen equivalent to chlorine	.36	.32	
	100.00	100.92	

COTTON HULL AND HARD WOOD ASHES.

8003. Sampled by Olin Wheeler, Buckland, from stock of Olds & Whipple, Hartford.

ANALYSIS.

Phosphoric Acid, water-soluble	none
" " citrate-soluble	1.78
" " insoluble	1.92
" " total	3.70
Potash, soluble in water	3.94

The valuation of this mixture per ton—reckoning citrate-soluble and insoluble phosphoric acid at 5 and 2 cents per pound respectively, and water-soluble potash at 5 cents per pound—is $6.49. The cost price was $25.00 per ton.

WOOD ASHES AND LIME KILN ASHES.

In the table, p. 146, are given twenty-one analyses of "unleached wood ashes," and one each of leached wood ashes and lime kiln ashes.

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* Report N. C. Sta. 1892, p. 99.

† "Soda, undetermined and loss."

§ Bull. 33, Office Expt. Sta. p. 115.

Lime Kiln Ashes.

A ton of the lime kiln ashes contains 868 pounds of lime, of which 344 pounds are in form of carbonate and 524 pounds are chiefly in form of hydrate.

Allowing 4¼ cents per pound for the potash in this sample, the lime costs about 47 cents per 100 pounds.

Wood Ashes.

As the table of analyses shows, these ashes are not simply a potash fertilizer, but are often and sometimes chiefly valuable as a source of lime in the form of carbonate.

Of the samples this year examined, one, No. **8275**, contains but 1.76 per cent. of potash and over 30 per cent. of sand, and is, therefore, not pure but badly adulterated unleached wood ashes.

The percentage of potash in the other twenty samples has ranged from 3.44 to 8.60, and that of phosphoric acid from .97 to 2.69. Lime has ranged from 27.29 to 50.96, and sand and soil from 5.85 to 20.39.

The average composition of unleached wood ashes, for the last three years, has been as follows :—

	1895. 16 Samples.	1896. 22 Samples.	1897. 21 Samples.
Potash, soluble in water	4⅛	5⅓	5½
Phosphoric Acid	1½	1½	1⅕
Lime	34	32⅓	32⅓
Sand and Soil	12¼	11	10⅓
Charcoal	2	2½	2
Cost per ton	$10.75	10.36	10.30

Ashes are sometimes sold with a guarantee of 5.0 per cent. of "potash." This Station, as a rule, determines only the potash soluble in water; for the reason that only potash which is freely soluble can be regarded as immediately available to vegetation. Green sand marl, feldspar and glass all may contain considerable quantities of "potash," but in forms which yield it up to the roots of plants extremely slowly.

Sample **8753** in the table of analyses contains 4.37 per cent. of potash, but only 3.74 per cent. of water-soluble or quickly available potash. Sample **6648** also contains .69 per cent. of potash insoluble in water, and doubtless all the other samples contain more or less insoluble potash which was not determined and is not worth determining.

SOURCES, ANALYSES AND COST OF

Station No.	Dealer.	Sampled or sent by
	UNLEACHED WOOD ASHES.	
8744	Bowker Fertilizer Co., Boston, Mass.	W. G. Grupe, New Canaan
6570	A. L. Hartness, Detroit, Mich.	S. W. Hurlburt, New Haven
8057	" " "	A. E. Plant, Branford
8251	" " "	N. S Platt, Cheshire
8272	" " "	H. C. C. Miles, Milford
8306	" " "	N. D. Platt, Milford
8739	" " "	F. Sherwood, Bridgeport
8186	F. R. Lalor, Dunville, Ontario, Canada	J. H. Burton, New Haven
8240	" " " "	Stock bought by Edward Hall, Plainfield
8743	" " " "	W. G. Grupe, New Canaan
8753	" " " "	D. N. Clark, Bethany
8348	" " " "	A. N. Clark, Milford
8742	Nichols, Mann & Son, Trenton, Mich	W. G. Grupe, New Canaan
6648	Charles Stevens, Napanee, Ontario, Canada	J. B Cannon, West Suffield
6782		J. Norris Barnes, Yalesville
6673	E. N. Austin, Suffield	H. H. Austin, Suffield
8183	J. Frank Ellwood, Fairfield	A. P. Wakeman, Fairfield
8956		Edwin Hoyt, New Canaan
8274	No. 1	Alden Solmons, So. Norwalk
8275	No. 2	" " "
6676		T. Soule, New Milford
	LEACHED WOOD ASHES.	
8347	James A. Bill, Lyme	N. D. Platt, Milford
	LIME KILN ASHES.	
6646	Frank Lee, Redding	Lloyd Godfrey, Cannon Station

As respects the cost of lime in these ashes, we find that on the average a ton of unleached wood ashes this year has contained 108 pounds of water-soluble potash, 24 pounds of phosphoric acid and 650 of lime. Allowing 5 cents per pound each for potash and phosphoric acid, the pure lime (calcium oxide) in the twenty samples would cost 57 cents per 100 pounds, or 10 cents more per hundred than in lime kiln ashes.

Leached Wood Ashes.

The single sample analyzed, No. **8347**, has the usual composition, containing over 36 per cent. of water, sand and charcoal.

WOOD ASHES AND OF LIME KILN ASHES.

Potash Soluble in Water.	Potash Soluble only in Acids.	Phosphoric Acid.	Lime, Calcium Oxide	Carbonic Acid	Sand and Soil.	Charcoal.	Cost per Ton.
4.27	....	1.25	31.91	19.56	9.95	1.32	$ 9.50
8.60	....	1 68	32.49	18.72	11.75	2.39	....
6.06	....	1.61	32.00	18.48	12.96	2.23	....
5.66	....	1.54	28.23	17.58	9.90	2.82	9.00
5.95	....	1.55	27.77	17.03	13.45	1.77	14.00
5.80	....	1.46	29.86	18.69	11.21	3.17	9.00
4.65	....	1.29	28.25	16.37	12.82	2.61	10.00
4 66	....	1.34	34.72	19.63	7.97	1.60	10.50
6.38	....	1.45	33.71	24.78	10.02	2.17	11.00
5.03	....	1.41	27.29	17.99	10.19	1.75	9.50
3.74	0.63	1.34	29.53	18.96	9.96	2.01	9.50
4.70	....	1.28	35.55	19.76	5.98	1.36	10.00
4.14	....	0.93	31.32	17.59	6.14	1.21	8.00
6 68	0.69	1.56	36.86	21.56	6.32	1.51	12.50
6 13	....	2.33	33.12	23.00	20.39	2.97	....
5.26	....	2.69	50.96	19.79	5.85	1.03	11.00
6.16	....	1.28	30 47	18.95	12.39	2.73	10.00
3.44	....	.97	28.38	15.46	6.56	2.89	....
6.72	....	1.92	29.76	19.78	12.98	2.87	....
1.76	....	1.59	24.40	8 31	31.13	9.85	....
3.98	....	1.16	37.45	22.98	15.22	1.65	10.50
0.36	....	1.68	15.12	18.90	6.01*	1.70	....
1.04	....	0.93	43.44	13.43	3 45	1.35	5.00

LIME.

6517. Vermont Lump Lime. Sold by H. D. Clark & Co., 961 Grand avenue, New Haven.

6518. New Milford Lime. Sold by H. D. Clark & Co., 961 Grand avenue, New Haven, for $1.25 per barrel. Sampled by S. W. Johnson.

8803. "Shell Lime" sent by Prof. C. S. Phelps, Storrs.

8142. Slaked Lime from Seymour Paper Co., Windsor Locks.

8145. Lime sold by E. M. Austin, Suffield.

Nos. **8142** and **8145** were sampled and sent by H. H. Austin, Suffield.

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* Water 31.80

ANALYSES.

	6517	**6518**	**8803**	**8142**	**8145**
Moisture and Water of hydration	2.41	0.80	28.49*	21.62	20 98
Matters Insoluble in Acid	2.56	0.91	13.84	.24	1.55
Oxide of Iron and Alumina	....	....	2.01	1.92	3.91
Lime	59.90	58 68	36.26	72.50	71.02
Magnesia	35.13	39.30	trace	.72	.98
Phosphoric Acid	trace	trace	trace	....	....
Carbonic Acid	trace	trace	19.40	3.50	2.27
	100.00	99.69	100.00	100.50	100.71

TOBACCO STEMS.

6559. Ground Tobacco Stems, sent by Olin Wheeler, from stock of Olds & Whipple, Hartford.

6530. Tobacco Stems (not ground), sent by F. H. Gaskill, New London.

ANALYSES.

	6559	**6530**
Moisture	....	11.26
Nitrogen	2.74	1.04
Phosphoric Acid	.92	.56
Potash	10.08	4.98
Cost per ton	$20.00	

If the nitrogen, phosphoric acid and potash in these goods are reckoned to be worth 12, 4½ and 5 cents per pound respectively, the valuation per ton of the ground stems, **6569,** will be $17.48 and of the unground stems, **6530,** $7.98.

GARBAGE FERTILIZER.

8104. Sent by J. J. Beardsley, New Preston, from stock of F. J. Hanford, New Preston, and stated to be made by the Bridgeport Utilization Co.

ANALYSIS.

Organic Nitrogen	2.88
Phosphoric Acid, soluble	none
" " reverted	2 27
" " insoluble	1.52
" " total	3.79
Potash, soluble in water	0.59

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* Determined by difference.

The valuation on the same basis as nitrogenous superphosphates is $11.47 per ton.

EARTH IMPREGNATED WITH SEWAGE.

6531. This material was taken from the filtration beds where the Meriden sewage is purified, and is stated to be the solid material discharged by the sewer, from which the fluid sewage has drained.

Sent by H. J. Moss, West Cheshire, who wished to know whether it was worth carting several miles for use as a manure. The material contained :

Water	23.71
Sand and Soil	68.32
Mineral matter soluble in acid*	3.70
Organic matter†	4.27
	100.00

* Containing phosphoric acid 0.14.
potash 0.05.
† Containing nitrogen 0.20.

This material, so far as nitrogen, phosphoric acid and potash are concerned, has the composition of a good soil, but has no value as a manure that would pay for carting.

REVIEW OF FERTILIZER SALES IN CONNECTICUT.

No close estimate can be given of the number of tons of commercial fertilizers annually sold in this State. An estimate made in 1887 [Report of this Station for 1887, p. 182], based on statements received from two-thirds of the number of firms selling fertilizers in the State, gave a total of 16,700 tons, costing $500,000.

An estimate made in a similar way in 1894 (Report of this Station for 1894, p. 72), gave a total of 22,500 tons, representing a total annual outlay for commercial fertilizers of at least $675,000.

This estimate does not include wood ashes, cotton hull ashes, or tobacco stems, and only a small part of the cotton seed meal which is used largely as a fertilizer.

The following table shows the number of firms which sold fertilizers in this State, in compliance with the fertilizer law, during

NUMBER OF MANUFACTURERS WHOSE FERTILIZERS HAVE BEEN LEGALLY SOLD IN CONNECTICUT, 1883–1897, AND NUMBER OF BRANDS SOLD YEARLY, WITH COST AND VALUATION.

		1883	1884	1885	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897
Year		1883	1884	1885	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897
Number of firms which complied with Fertilizer Law		38	45	51	46	42	44	38	40	41	38	38	43	47	52	56
No. of brands entered for sale by these firms.	Special Manures	23	22	18	19	21	30	31	38	40	45	57	76	75	91	102
	Other Superphosphates	43	58	68	67	70	71	67	72	68	67	72	74	89	104	111
	Bone Manures	16	22	32	28	22	23	23	22	22	22	23	27	28	33	39
	Chemicals, fish, tankage and pomace	13	15	20	20	14	13	11	14	19	29	16	18	17	27	29
Total		95	117	138	134	127	137	132	146	149	154	168	195	209	255	281
Average number of brands per manufacturer		2.5	2.6	2.7	3.0	3.0	3.1	3.5	3.6	3.6	4.1	4.4	4.5	4.4	4.9	5.0
Average ton price of Superphosphates		$41.42	40.73	37.60	36.58	35.74	34.55	34.10	33.80	33.93	35.28	32.99	32.93	32.32	31.56	30.44
" valuation "		$34.92	33.13	30.47	29.42	28.45	28.70	29.10	28.57	28.13	25.46	23.48	23.30	23.37	21.18	20.71
Percentage Difference		18.7	22.9	23.4	24.3	25.6	20.3	17.2	18.3	20.6	27.8	40.5	41.3	38.2	49.0	46.9
Average ton price of Special Manures		$49.98	49.95	44.80	42.56	42.52	39.47	40.25	39.18	38.84	38.28	37.76	38.13	37.33	36.19	34.34
" valuation " "		$42.53	44.20	38.70	36.70	35.20	33.99	35.20	32.90	31.64	30.70	29.35	28.62	27.94	25.64	24.28
Percentage Difference		17.5	13.0	16.0	16.0	20.9	16.1	14.3	19.0	22.8	25.0	28.6	33.2	33.6	41.1	41.4
Average ton price of bone manures		----	----	$34.59	36.14	35.00	32.80	34.11	33.00	33.66	33.12	31.70	33.59	32.09	31.18	29.61
" valuation " "		----	----	$34.58	38.24	40.41	39.07	37.49	37.77	35.58	35.90	32.01	32.01	31.03	28.17	28.03

each year from 1883, when the law went into effect, to the present time. It also shows the number of brands sold, of each of the four classes, and the average costs and valuations of special manures, other superphosphates and bone manures.

It appears that the number of firms doing business in the State has not very greatly increased.

Thus 46 firms made fertilizers which were sold in Connecticut in 1886, and in no year till 1895 was there a larger number.

Since 1889 there has been a constant increase, year by year, in the number of brands sold. This number, in that year was 132, in 1891, 149; in 1893, 168; in 1895, 209; and in 1897, 281.

This increase has been almost wholly in the number of brands of special manures, designed for particular crops or classes of crops. Since 1885 the increase in the brands of this sort has been constant, while in the ten years from 1885–1895 there was scarcely any increase in the number of nitrogenous superphosphates, bone manures or chemicals.

In 1883 the average number of brands entered for sale by each manufacturer was between two and three; at the present time it is five.

The average cash ton price of special manures, which was about $50 in 1883, has gradually sunk to about $37 in 1897.

The ton price of nitrogenous superphosphates has sunk in the same time from $41 to $31.

There has been less change in the price of ground bone, though the tendency has been also downwards.

REVIEW OF THE FERTILIZER MARKET.

For the Year ending October 31, 1897.

By E. H. Jenkins.

Nitrogen.

Nitric Nitrogen.

The *wholesale* New York quotation of nitrogen in this form in November, 1896, was 11.6 cents per pound. It rose in December and January to 12.1, and then fell to 10.5 cents per pound in August, remaining at that figure during September and October.

The average of the monthly quotations for the year ending October 31, 1897, is 11.4 cents per pound, a little more than in the previous year.

The average of monthly quotations for a number of years has been as follows:—

Year	1897	1896	1895	1894	1893	1892	1891	1890
Average quotation, cents per pound, *wholesale*	11.4	11.1	11.4	13.0	12.7	12.1	12.9	11 5

The *retail* price of nitrogen in nitrate in this State at freight centers, as shown on page 86, has been about 14.6 cents per pound.

Ammonic Nitrogen.

The *wholesale* New York quotations of nitrogen in form of sulphate of ammonia has ranged during the year between 11 cents and 9.7 cents per pound. The average of the monthly quotations has been 10.5 cents.

The corresponding averages of previous years have been:—

Year	1897	1896	1895	1894	1893	1892	1891
Average quotation, *wholesale*, cents per pound	10.5	11.1	14.3	17.3	15.7	14.6	15.6

During the last two years the *wholesale* cost of nitrogen in sulphate of ammonia has been as low as in nitrate of soda.

There has been little demand for sulphate of ammonia in the Connecticut retail market, and at retail, nitrogen in this form, as seen on page 88, costs considerably more than in nitrate, viz: 14.4 cents per pound.

Organic Nitrogen.

The *wholesale* New York quotations of nitrogen in the forms of red blood, black or low grade blood and concentrated tankage for each month in the year are shown in the table on page 157. The fluctuations have not been large and the prices have ruled decidedly higher during August, September and October, 1897.

The average wholesale quotations of nitrogen in form of high grade and low grade blood have been a fraction of a cent per pound higher in 1897 than in 1896, but in form of concentrated tankage the quotations have been lower in 1897.

These forms of organic nitrogen do not meet with much sale in our retail market.

Low grade tankage, fish, bone, and especially cotton seed meal are the forms most used by those who mix their own fertilizers or apply fertilizers to their land unmixed.

Cotton seed meal, as shown on page 89, has been the cheapest form of quickly-available organic nitrogen in our market.

PHOSPHATIC MATERIALS.

Rough bone was quoted at $16.50 per ton, *wholesale*, till September, when it rose to $17.25, and to $17.50 in October. Ground bone was quoted through the year at $21.75 per ton wholesale.

Rock phosphate has shown scarcely any change in quotation during the year.

Sulphuric acid, 66°, rose from .82½ in November, 1896, to 1.12½ in the following January, and declined in September to .97½.

Available phosphoric acid, in form of dissolved rock phosphate, fell from 2.73 cents per pound, *wholesale*, in November, 1896, to 2.53 cents per pound in May, 1897, at which figure it is still quoted.

The figures given on page 94 show that *at retail*, in this State, available phosphoric acid in form of dissolved phosphate rock has cost about 5 cents per pound, and in form of dissolved bone black, about 6½ cents per pound.

POTASH.

Muriate of Potash.

From November, 1896 to April, 1897, the average monthly quotation, *wholesale*, of potash in this form has been 3.59 cents per pound. Since that date it has been 3.64 cents.

The retail price in Connecticut, as shown on page 98, has ranged from 3.9 to 4.5 cents per pound.

The Double Sulphate of Potash and Magnesia.

From November, 1896 to April, 1897, the average monthly quotation, wholesale, of potash in this form has been 3.94 cents per pound. Since that date it has been 4.12 cents.

The retail price in Connecticut, as shown on page 98, has been 5.7 cents per pound.

High Grade Sulphate of Potash.

The *wholesale* New York quotation during the last twelve months has been uniformly 4.10 cents per pound for potash in this form.

At retail, in Connecticut, as appears on page 98, potash in this form has ranged in price from 4.7 to 5.5 cents per pound.

These quotations are taken from the "Oil, Paint and Drug Reporter," published in New York. The weekly quotations for each month are averaged, and this average is taken as the quotation for the month.

The following explanations will help in the examination of the market quotations, and will also show the basis on which they have been interpreted in this review :

Phosphate rock, *kainit*, *bone*, *fish-scrap*, *tankage* and some other articles are usually quoted and sold by the ton. The seller usually has an analysis of his stock, and purchasers often control this by analysis at the time of the purchase.

Sulphate of ammonia, nitrate of soda and the potash salts are quoted and sold by the pound, and generally their wholesale and retail rates do not differ very widely.

Blood, azotin and concentrated tankage are quoted at so much "per unit of ammonia." To reduce ammonia to nitrogen, multiply the per cent. of ammonia by the decimal .824 (or multiply the per cent. of ammonia by 14 and divide that product by 17). A "unit of ammonia" is one per cent., or 20 pounds per ton. To illustrate: if a lot of tankage has 7.0 per cent. of nitrogen, equivalent to 8.5 per cent. of ammonia, it is said to contain 8½ units of ammonia, and if quoted at $2.25 per unit, a ton of it will cost 8½ × 2.25 = $19.13.

The term "ammonia" is *properly* used only in those cases where the nitrogen actually exists in the form of ammonia, but it is a usage of the trade to reckon all nitrogen, in whatever form it occurs, as ammonia.

To facilitate finding the actual cost of nitrogen per pound from the cost per unit of ammonia in the market reports, the following table is given :

Ammonia at	$3.00	per unit	is equivalent to	Nitrogen at	18 2	cts. per lb.
"	2.90	"	"	"	17.6	"
"	2.80	"	"	"	17.0	"
"	2.70	"	"	"	16.4	"
"	2.60	"	"	"	15.8	"
"	2.50	"	"	"	15.2	"
"	2.40	"	"	"	14.6	"
"	2.30	"	"	"	14 0	"
"	2.20	"	"	"	13.4	"
"	2.10	"	"	"	12.8	"
"	2.00	"	"	"	12.2	"
"	1.90	"	"	"	11.6	"
"	1.80	"	"	"	11.0	"
"	1.70	"	"	"	10.3	"
"	1.60	"	"	"	9.7	"
"	1.50	"	"	"	9.1	"

Commercial sulphate of ammonia contains about 20.8 per cent. of nitrogen, though it varies somewhat in quality. With that per cent. of nitrogen (equivalent to 25.25 per cent. of ammonia).

If quoted at	2.6	cents per pound,	Nitrogen	costs	12.5	cents per pound.
"	2.5	"	"	"	12.0	"
"	2.4	"	"	"	11.5	"
"	2.3	"	"	"	11.1	"
"	2.2	"	"	"	10.6	"
"	2.1	"	"	"	10.1	"
"	2.0	"	"	"	9.6	"

Commercial nitrate of soda averages 95 per cent. of pure sodium nitrate, or 16 per cent. of nitrogen.

If quoted at	2.5	cents per pound,	Nitrogen	costs	15.6	cents per lb.
"	2.4	"	"	"	15.0	"
"	2.3	"	"	"	14.4	"
"	2.2	"	"	"	13.8	"
"	2.1	"	"	"	13.2	"
"	2.0	"	"	"	12 5	"
"	1 9	"	"	"	11.9	"
"	1.8	"	"	"	11.3	"
"	1.7	"	"	"	10.6	"
"	1.6	"	"	"	10.0	"
"	1.5	"	"	"	9.4	"

Commercial Muriate of Potash usually contains 50½ per cent. of "actual potash," or potassium oxide.

If quoted at	2.20	cents per pound,	Potassium Oxide	costs	4.35	cents per lb.
“	2.15	“	“	“	4.25	“
“	2.10	“	“	“	4.15	“
“	2.05	“	“	“	4.06	“
“	2.00	“	“	“	3.96	“
“	1.95	“	“	“	3.86	“
“	1.90	“	“	“	3.76	“
“	1.85	“	“	“	3.66	“
“	1.80	“	“	“	3.56	“
“	1.75	“	“	“	3.46	“
“	1.70	“	“	“	3.36	“

High Grade Sulphate of Potash, as it is found in the Connecticut market, contains about 49.2 per cent. of actual potash.

If quoted at	2.50	cents per pound,	Potassium Oxide	costs	5.1	cents per lb.
“	2.45	“	“	“	5.0	“
“	2.40	“	“	“	4.9	“
“	2.35	“	“	“	4.8	“
“	2.30	“	“	“	4.7	“
“	2.25	“	“	“	4.6	“
“	2.20	“	“	“	4.5	“
“	2.15	“	“	“	4.4	“
“	2.10	“	“	“	4.3	“
“	2.05	“	“	“	4.2	“
“	2.00	“	“	“	4.1	“

The Double Sulphate of Potash and Magnesia has about 26½ per cent. of potassium oxide.

If quoted at	1.00	cents per pound,	Potassium Oxide	costs	3.77	cents per lb.
“	1.05	“	“	“	3.96	“
“	1.10	“	“	“	4.15	“
“	1.15	“	“	“	4.34	“
“	1.20	“	“	“	4.53	“
“	1.25	“	“	“	4.73	“
“	1.30	“	“	“	4.90	“

The following table shows the fluctuations in the wholesale prices of a number of fertilizing materials in the New York market, since November, 1893. The price given for each month, is the average of the four weekly quotations of that month. Sulphate of ammonia is assumed to contain 20.8 per cent. and nitrate of soda 16.0 per cent. nitrogen, muriate of potash 50½ per cent., high grade sulphate 49.0 per cent. and double manure salt 26.5 per cent. of actual potash.

WHOLESALE PRICES OF FERTILIZING MATERIALS.

		Cost of Nitrogen at wholesale in						Cost of Potash at wholesale in			Available Phosphoric Acid in Dissolved South Carolina Rock. Cents per pound.
		Dried Blood.									
		Red. Cents per pound.	Black or low grade. Cents per pound.	Azotin or Ammonite. Cents per pound.	Concentrated Tankage. Cents per pound.	Nitrate of Soda. Cents per pound.	Sulphate of Ammonia. Cents per pound.	Muriate of Potash. Cents per pound.	Double Manure Salt. Cents per pound.	High Grade Sulphate of Potash. Cents per pound.	
1893.	November	16.6	15.7	16.6	16.3	11.7	16 4	3.74	4.33	4.15	3.09
	December	16.1	15.3	16.1	16.3	11.3	16.4	3.74	4.33	4.15	3.09
1894.	January	15.9	14.7	16.0	15.9	12.0	16.7	3.58	4.30	4.18	3.09
	February	15.9	15.2	15.9	15.4	11.7	18.4	3.71	4.44	4.28	3.09
	March	15.5	14.6	15.5	15.4	13.0	18.5	3.71	4.44	4.28	3.09
	April	14.5	13.9	14.2	13.3	14.0	17.6	3.84	4.54	4.39	2.98
	May	14 5	13.8	14.2	12.2	14.4	16.7	4.13	5.04	4.85	3.00
	June	13.2	12.6	13.1	12.2	14.3	16.7	4.13	5.04	4.85	3.00
	July	12.6	12.6	12.9	12.2	13.8	16 8	4.13	5.04	4.85	3.00
	August	13.3	12.6	13.3	12.3	13.7	17.7	4.13	5.04	4.85	3.09
	September	15.7	14.5	15.4	12.3	13 5	18.3	4.13	5.04	4.85	3.12
	October	15.1	14.4	15.2	12.4	12.9	17.5	4.13	5.04	4 85	3.12
	November	14.1	13.1	14.0	12 3	13.2	16.4	4 13	5.04	4.85	3.00
	December	13.5	12.4	13.1	12.3	12.9	16.0	4.13	5.04	4.85	3.10
1895.	January	12.7	12.2	13.0	12.3	12.1	15.0	3.54	4.24	4.13	3.50
	February	11.9	11.2	....	12.3	11.4	15.0	3.54	4.24	4.13	3.37
	March	12.1	10.5	....	12.3	10.4	15.0	3.59	4.32	4.20	3.37
	April	11.7	10.6	....	12 3	10.3	15.0	3.59	4.32	4.20	3.37
	May	12.1	10.8	....	12.3	10.5	14.3	3.59	4.32	4.20	3.37
	June	11.7	10.9	....	12.3	11.0	13.6	3.59	4.32	4.20	3.37
	July	11.6	10.7	....	12.3	10.9	13.4	3.60	4.32	4.20	3.37
	August	11.5	10.2	....	12.3	10.8	13.1	3.60	4.32	4.20	3.37
	September	11.8	10.2	....	12.3	11.3	13.0	3.60	4.32	4.20	3.23
	October	11.8	10.2	....	12 3	11.7	12.2	3.60	4.32	4 20	2.62
	November	11.7	9.9	....	12.3	11.6	12.0	3.60	4.32	*4.34	2.62
	December	11.7	9.8	....	12 3	11.1	12.0	3 60	4.32	4.34	2.62
1896.	January	11.0	9.8	....	12.3	10.8	11.6	3.60	4.32	4.34	2.62
	February	10.8	9.8	....	12.3	10.7	11.3	3.55	3.99	4.13	2.62
	March	10.8	9.8	....	12.3	10.7	11.5	3.53	3.87	4.05	2.73
	April	10.8	9.8	....	12.3	10.7	11.1	3.60	3 94	4.10	2.73
	May	10.7	9.9	....	12.3	10.9	10.8	3.60	3.94	4.10	2.73
	June	10.5	9.8	....	12.3	10.8	10.8	3.60	3.94	4.10	2.73
	July	10.5	9.8	....	12.6	10.8	10.8	3.60	3.94	4.10	2.73
	August	10.5	9.8	....	11.4	10.8	10.7	3.60	3.94	4.10	2.73
	September	10.2	9.1	....	9.5	10.8	10.5	3.60	3 94	4.10	2.73
	October	10.3	9.0	....	9.5	11.3	10.5	3.60	3 94	4.10	2.73
	November	11.0	10.1	....	9.4	11.6	10.8	3.59	3.94	4.10	2.73
	December	11.2	10.8	....	9.5	12.1	10.4	3.59	3 94	4.10	2.73
1897.	January	10.7	10.1	....	9.4	12 1	11.0	3.59	3.94	4.10	2.73
	February	10.6	10.0	....	9.4	11.9	11.0	3.59	3.94	4.10	2.73
	March	10.5	10.1	....	9.3	11.9	10.9	3.59	3.94	4.10	2.73
	April	10.5	9 9	....	9.4	12.3	10.8	3.60	3.97	4.10	2.68
	May	10.3	9.7	....	9.9	11.5	10.7	3.64	4.12	4.10	2.53
	June	10.1	9.7	....	9.9	11.0	10.3	3.64	4.12	4.10	2.53
	July	10.7	10.1	....	9.9	10.6	10.2	3.64	4.12	4.10	2.53
	August	11.1	10.5	....	10.1	10.5	9 .7	3.64	4.12	4.10	2.53
	September	11.8	11.3	....	11.5	10.5	10.4	3 64	4.12	4.10	2 53
	October	12.0	11 8	....	11.7	10.5	10.5	3.61	4 12	4.10	2.53

* Calculated on basis of 49 per cent. potash in the salt.

THE MILDEW OF LIMA BEANS. (*Phytophthora Phaseoli*, Thaxter.)

BY WM. C. STURGIS.

This mildew was first described by Thaxter in the Annual Report of this Station for 1889, p. 167, and it is unnecessary to add anything to that description. For the past two or three years it has not been very prevalent owing to dry weather, but during the summer of 1897 the conditions were such that in many places the effects of the fungus have been most disastrous. Investigations have been made to determine, if possible, the manner in which the young pods are infected, and to secure some preliminary information as to the means which seem most likely to prevent the spread of the fungus.

About the middle of June the spraying of lima beans was begun on the truck farm of Messrs. Atwater Bros., of New Haven, and a little later similar experiments were started at East Haven on the farm of Mr. Sidney B. Smith. By the first of July the vines were blooming profusely, and a week later the mildew made its appearance on the young pods. On July 12th and 13th a very heavy downpour of rain did great damage; from that time until September rains were abundant and frequent, and the beans, which in both cases were planted on rather low ground, suffered severely. Meanwhile the occurrence of the mildew on the pods at a very early stage of their growth, led to the supposition that insects were responsible in a measure for the spread of the fungus. Examination of the flowers served to confirm this supposition, and a few words regarding the structure of the bean flower will explain how infection takes place (see cut on p. 166).

The conspicuous portions of the bean flower consist of an upright petal known as the "standard"; two narrower petals, distinct, projecting forward below the standard and known as the "wings"; and two petals united in the form of a closed, spirally coiled tube, occupying a position between the standard and the wings and called the "keel." (Fig. 1.) At the base of the keel is the ovary or young pod surrounded by the stamens and prolonged upwards into the style. The long stamens and style are completely enclosed in and protected by the keel.

Under such conditions cross-fertilization would seem to be impossible, especially as the pollen is shed abundantly from the anthers which are borne upon the stamens in close proximity to the upper portion of the style, and neither the stigma nor the anthers appear beyond the end of the tube in which they are enclosed. But the wings form a convenient resting place for visiting bees in search of nectar, and in case a bee lights upon them his weight deflects them and at the same time draws the keel down and backward, thus causing the stigma and the hairy portion of the style covered with pollen to protrude from the mouth of the tube. (Figs. 2 and 3.) As the insect plunges his head into the flower, the stigma and pollen-laden style come into contact with his abdomen and cross-fertilization is assured by subsequent visits to other flowers. But fungous infection is assured with hardly less certainty, provided the bee has previously had contact with the spores of the fungus. In that case we should expect to find the first attack of the fungus at the two points where the bee, in his search for nectar, touched the more moist and delicate tissues of the flower, viz., on the style and at the base of the ovary or pod.

A large number of flowers was examined and this supposition was strikingly confirmed. The mildew was found in many of the flowers, and in every case it occurred on the spots above mentioned and nowhere else. (Fig. 4.) It seems certain therefore, that the spread of this mildew is largely due to the agency of insects, particularly of bees, and this view is further confirmed by the fact that in the case of young pods the mildew almost always appears first at the base or tip and very rarely in the middle.

That the wind also plays an important part in the dissemination of this mildew, seems certain. When the vines are seriously mildewed the fungus frequently appears first, not at either extremity, but upon one side of an almost mature pod, and generally on the side farthest from the vine and least protected by leaves. Thaxter has also noted its occurrence on the leaves.

Neither of these cases can be due to infection on the part of insects, and we must conclude that the spores may be carried by the wind, or that water falling upon and dripping from infected portions may carry the spores down to sound pods hanging beneath. That mature, uninjured pods can be infected with the fungus and that the wind can disseminate it, is indicated by the following facts.

The lima beans on the Station grounds are on high land composed of a light sandy soil, and have never been affected with mildew. The rows run east and west. Directly south of them at a distance of about one hundred feet, but separated from them by a pile of lumber and a few trees, are two rows of bush limas running north and south. On August 14th, when the mildew had been abundant in the neighborhood for a month or more, the Station vines were examined and found to be entirely free from the fungus. A few mildewed pods were brought from a distance, and the spores from one of them were rubbed and dusted on the surface of a sound and nearly ripe pod at the east end of each row of the pole limas. Within a few days the mildew made its appearance on the infected pods, and from this point of vantage, the prevailing winds at the time being from the northeast and north, it swept down both rows and in two weeks the whole patch was completely mildewed. The spores had also been carried over a distance of one hundred feet to the bush limas and the mildew, beginning at the north end of the rows, that is, at the point nearest to the pole beans, spread rapidly down the rows. It is evident then, that spores placed upon the surface of a sound lima bean pod were enabled to start the disease, which thereupon spread with great rapidity in the direction of the prevailing wind.

The dissemination of this fungus has thus been fairly accounted for; whence it comes in the Spring and how it bridges over the Winter, is another question.

Since it can hardly be imagined that the delicate Summer spores could withstand the Winter, the fungus must perpetuate itself either by means of its vegetative threads or by resting-spores as in the case of certain related fungi. In the particular group to which the lima-bean mildew belongs, there are but four species. One is the dreaded potato mildew, *Phytophthora infestans;* the second, *Phytophthora Cactorum*, infests principally various species of the cactus family, and in this species resting spores or "*oöspores*" are known to occur; the third is the recently described tobacco-mildew, *Phytophthora nicotianæ*, from Java, which also produces oöspores; the fourth is the species here discussed. No oöspores are, with any certainty, known to occur in the potato mildew, and the most careful search has failed to discover them on the lima bean. It is possible that by keeping the refuse of a mildewed crop under constant observation throughout the Winter, oöspores may be found to develop, but it seems more probable that, like the potato mildew, this mildew depends for its propagation upon its mycelium. In either case it can be perpetuated only in the remains of the plants infested by it, and the precaution of burning all such refuse in the Autumn is therefore of primary importance.

It will be inferred from what has been said regarding the dissemination of this mildew, that its prevention by means of fungicides presents many difficulties. Being carried to the flowers by insects and there being protected by the conformation of the flower itself, it is impossible to reach it with fungicides or to protect the ovary from its attacks. The period of blooming too, is so long in the case of the bean that the danger of infection through the flowers continues practically throughout the whole season, and there is no possible means of preventing it. The only thing that we can hope to do by the use of fungicides is to protect the maturing beans from the spores which are borne to them by the wind or by water. And here a difficulty presents itself arising from certain defects in the method of culture usually employed. Most growers allow three or four vines to each pole and slant the poles so that the tops of two adjoining poles meet. The consequence is that every pole is overloaded, and the vines, reaching the top and there uniting and continuing their growth, produce a dense mass of leafage which effectually prevents anything like a free access of air and sunshine to the pods. At the same time this renders it very difficult to reach the pods with a fungicide. It is reasonable to suppose that by allowing, at the most, two vines to a pole, and by placing the poles upright, the increased healthiness of the vines would more than compensate for their decreased number. This is a matter which I hope to see tested another season.

Meantime various fungicides have been tried, and notwithstanding the continuous wet weather which was at the same time favorable to the mildew and unfavorable for spraying, the difficulty, always experienced in a test experiment, of attempting to prevent infection on one row or group of rows in the face of constant menance from unsprayed rows immediately adjacent, and the fact that we had to deal with a fungus easily disseminated by every breeze and developing with extraordinary rapidity, yet the results obtained were worthy of notice.

Four fungicides were used, viz. Bordeaux mixture in the proportion of five pounds each of lime and copper sulphate to fifty gallons of water; ammoniacal copper carbonate, made by dissolving six ounces of the carbonate in three pints of strong ammonia and diluting to fifty gallons; potassium sulphide, one ounce to two and a half gallons; and flowers of sulphur applied dry. The ammoniacal copper carbonate was not used at first, but only as a substitute for the Bordeaux mixture in the later sprayings, when it was desired to preserve the clean appearance of the pods.

We will examine first the method of treatment and the results obtained on the farm of Messrs. Atwater Bros., as shown in the following table.

	Treatment.	Number of Applications.	Number of Marketable pods.
Row 2.	Bordeaux.	3	296 (2 pecks)
	Am. sol. Copper Carb.	2	
Row 3.	0		25
Row 4.	Sulphur.	2	16
	Potass. sulphide.	2	
Row 5.	0		13
Row 6.	Potass. sulphide.	3	68
	Sulphur.	1	
Row 7.	0		11
Row 8.	Am. sol. Copper Carb.	1	55
	Potass. sulphide.	1	

Each row contained forty-four poles. The first application was made on June 23rd, the last on Sept. 7th. The mildew made its first decided appearance about Aug. 10th.

This experiment was merely an adjunct to one with celery on an adjoining piece of ground. The beans received whatever quantity of fungicide was left over after each treatment of the celery, so that the treatment of the beans was neither as careful nor as thorough as in the more extensive experiment at Mr. Smith's. Nevertheless I consider the results as more reliable because, owing to the almost complete destruction of the crop by mildew, only one small gathering was made previous to the test-gathering of Sept. 21st. That gathering therefore, represented practically the total crop of marketable beans, those which had matured earliest, had escaped the mildew and still hung upon the vines, being included among the "marketable pods." On the Smith farm however, the mildew was not so destructive, several gatherings had been made previous to the one test-gathering of Sept. 24th, and the latter therefore represented only the condition of the pods at that date and did not give a fair idea of the condition of the crop as a whole. For some reason not wholly clear, perhaps because of lessened insect activity, the mildew ceased spreading about Sept. 10th and from that date until Sept. 24th the condition of the unsprayed vines constantly approximated that of the sprayed vines. In this case conclusive results could have been obtained only from observations of consecutive gatherings made every two weeks throughout the season or possibly from one gathering made while the mildew was still spreading; but this fact was overlooked until too late.

To return to the experiment on the Atwater farm, the value of Bordeaux mixture in checking the mildew is apparent from the figures given. Row 2 is the only one which yielded any considerable crop and the figures here would have shown a still more favorable result but for the fact that two or three weeks previous to the test gathering, through a misunderstanding, a quantity of beans was picked from this row, as stated above.

On Row 4 treatment was begun with sulphur, but it soon became evident that the treatment was inefficient; it was also very difficult to apply the sulphur dry when the vines had attained their growth, and potassium sulphide was therefore substituted. The single application of sulphur on Row 6 was due to an error, but it can hardly be considered as vitiating the general result.

The conclusion to be drawn from this experiment is that even in a season most favorable to the lima-bean mildew, thorough treatment of the vines with Bordeaux mixture will insure a crop.

For the reasons stated above, the figures derived from the single gathering on the Smith farm are unreliable, but at the same time they are worthy of notice.

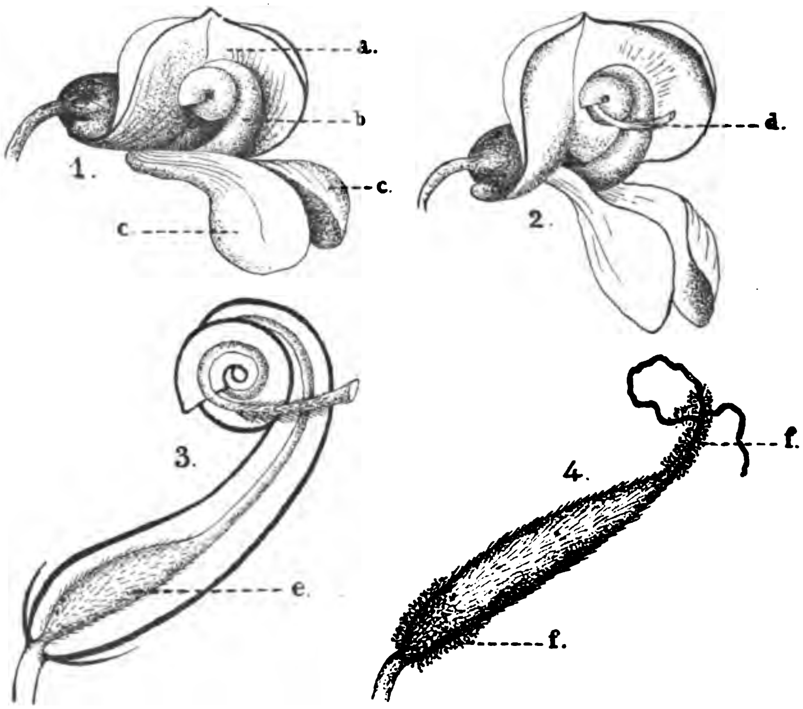
The rows treated twice with Bordeaux mixture and twice with the ammonia solution of copper carbonate yielded 80% of pods showing no trace of mildew, the remaining 20% consisting of pods more or less diseased but still marketable; the rows treated three times with sulphur and once with potassium sulphide yielded 68% of clean pods; and the rows treated four times with potassium sulphide yielded 49%. These figures are to be compared with the yield of clean pods from the check rows amounting to 55%. These figures give but little idea of the relative condition of the vines sprayed with Bordeaux mixture and the others whether sprayed or not. The fruiting tips of the latter were almost without exception badly mildewed and bore from two to ten young pods dead and shrivelled from the direct attacks of the fungus or from the cutting off of their nutriment by reason of the diseased condition of their common stalk. These dead tips were far less evident on the rows sprayed with Bordeaux.

But the best evidence of the value of Bordeaux mixture in this connection is the testimony of Mr. Smith himself to the effect that from a previous picking from the rows included in the experiment he estimated that the quantity of marketable beans from the rows sprayed with Bordeaux mixture exceeded that from any of the other rows by fully one-third.

Mr. Smith further stated his intention of providing himself with an outfit and treating all of his beans next year.

The time and expense necessary to spray an acre of beans is of course considerable, nor do the experiments of the past season throw much light upon this aspect of the question for several reasons. The frequent rains necessitated a greater number of applications than would be required in an ordinary season; inasmuch as mildewed vines surrounded those which were subjected to treatment, the Bordeaux mixture had to be applied in greater strength and more thoroughly than would have been the case had all the vines been sprayed; and lastly, the spraying outfit was rather primitive, consisting merely of a small force-pump, a single Vermorel nozzle and a pail. With a large pump fitted to a barrel and two nozzles mounted on a Y connection and spreading about two feet, two men should be able to spray an acre of pole beans in a day. If a weaker form of Bordeaux mixture were used, say 3 lbs. of copper sulphate and 2 lbs. of lime to 50 galls. of water, the cost of materials should not exceed $2.00 per acre for each application. In ordinary seasons, three applications of this weaker mixture would be sufficient. On this basis the total expense would amount to about $15.00 per acre for the season.

In conclusion, it must be borne in mind that much can be done by the grower, apart from the application of fungicides, to lessen the susceptibility of lima beans to mildew. The selection of well-drained land and a light soil is important, but above all, care must be taken, by reducing the number of vines in a hill and by planting the poles erect, to insure conditions as little favorable as possible to fungous disease. With these precautions it should be necessary to resort to the use of a fungicide only in exceptionally damp seasons.



(SEE PAGES 129 AND 130.)

Fig. 1.—Blossom of Bean; *a*, standard. *b*. keel, enclosing the stamens and pistil. *c*, wing-petals.

Fig. 2.—The same. Wing-petals depressed as by the weight of a bee, causing the style to protrude, *d*.

Fig. 3.—The same enlarged Petals and stamens removed, and keel cut open to show the style coiled inside. *e*, ovary or young pod.

Fig. 4.—Young pod, after the fall of the blossom, and with the shrivelled style still attached. The mildew is seen at *f*.

(Figures 1 and 2 after Gray.)

ON THE PREVENTION OF LEAF-BLIGHT AND LEAF-SPOT OF CELERY. (*Cercospora Apii*, Fres., and *Septoria Petroselini*, Dmz. var. *Apii*, Br. & Cav.)

BY WM. C. STURGIS.

These two diseases, generally occurring together or in succession on the leaves of celery, are undoubtedly the most serious trouble with which celery growers have to contend. The *Cercospora* usually appears early in the season, attacking first the lower leaves, upon which it produces irregular brownish blotches. The presence of the fungus on these diseased areas is often apparent to the naked eye as an ashy bloom on the surface of the dead tissue. The *Septoria* appears later, and although its effects upon the leaf are very similar to those produced by the *Cercospora*, it can easily be distinguished in its advanced stages by the appearance of the fruiting bodies—minute black dots scattered over the affected portion of the leaf. Both of these fungi cause the leaves to blight and turn yellow, and the *Septoria* especially continues to spread after the plants have been banked or boarded up, or stored.

In the Annual Report of this Station for 1892, attention was called, in this connection, to the highly beneficial effect of sulphur applied in a dry condition to the plants; but recent investigations, particularly those published in Bulletin 44 of the R. I. Agricultural Experiment Station, indicate that the trouble may be due primarily, not to the fungus itself, but to causes which render the celery plant peculiarly susceptible to fungous attack. Among these causes, the principal one is the substitution of level culture for trench culture. The latter consists in planting the celery in trenches which are then gradually filled in with earth as the plants grow; in level culture, to use the expressive language of the bulletin above referred to, "the plants are lined up on the surface and made to toe the mark like other vegetables." The roots of celery naturally feed near the surface and therefore, unless protected in some way, they are subjected, by the method of level culture, to all the temperature changes of the surface soil. This protection is afforded by the method of trench culture in which the roots are well covered and maintained at a uniformly cool temperature. In level culture this is not the case, and it is certainly noteworthy that the increase of celery blight has become apparent only since the abandonment of trench culture for the cheaper, less laborious and in many ways preferable system of level culture.

To combine the advantages of both systems all that is necessary is to grow the plants on the level and to protect the roots from rapid changes of temperature and moisture by means of a mulch. In the experiments at the Rhode Island Station this theory was tested in various ways. The application about the base of the plants of a mulch consisting of fresh sea-weed, lawn clippings, coarse stable manure, meadow hay, or even of "leaves from other blighted plants—which must have been teeming with spores of the disease," resulted in every case in preventing or checking the blight. A number of other facts are adduced in the bulletin above referred to, to show that while "it is understood that the lack of proper protection of the roots of celery plants is not the sole cause of all celery diseases, nevertheless this seems to be the principal fault of the 'level culture' method as it is now practiced in its highest form." I have quoted thus largely from the conclusion arrived at in Rhode Island, because it seems to me to be a very clear and reasonable explanation of the facts observed and to offer an effective means of preventing a trouble which seriously and with increasing severity threatens the celery growers of this State. At the same time however, it is of interest to note what may be done in this direction by means of fungicides. I have already noted the favorable results following the use of sulphur, and during the past year I have conducted similar experiments with this and other fungicides.

Permission was obtained from Messrs. Atwater Bros., of New Haven, to use a portion of their celery for this purpose, and early in August eight rows of newly-transplanted late celery were selected for the experiment. Each row measured 200 feet in length and contained about 420 plants. The land was rather low and the drainage facilities were insufficient to carry off the abundant rain-fall, so that a portion of the plants suffered from flooding, but enough remained healthy to form a fair basis for conclusions. Each row was divided into two equal portions, one of which received treatment with a fungicide, while the other served as a check. It was intended to try the value of mulching on the check portion of the rows, but lack of proper material and pressure of other work prevented the proprietors from carrying out this intention. Two half-rows received Bordeaux mixture, two potassium sulphide, two the ammonia solution of copper carbonate and the remaining two were dusted with sulphur.

The applications were made on Aug. 7th, Aug. 14th, Sept. 7th, and Sept. 21st. Tabulated statements of the results are impracticable, but the appearance of the rows was carefully noted at intervals. The *Cercospora* became noticeable throughout the field on Aug. 14th, during a period of hot, clear weather preceded and followed by a succession of cloudy or rainy days. At the time of the last spraying the effects of the various fungicides was evident.

A reference to p. 44 of the Annual Report of this Station for 1892, will show that, in one instance at least, the use of sulphur apparently preserved the celery crop intact. That season however, presented conditions of normal rain-fall, while the excessive rain-fall of the present season was not only highly conducive to fungous activity, but also rendered the plants more susceptible by decreasing their vigor at a critical period of their growth. Moreover, results published by the New Jersey and the Cornell Experiment Stations indicate that the ammoniacal copper carbonate solution is more effective than sulphur in checking celery blight. Our experiments of this year therefore, are of special interest.

It is not surprising, under existing circumstances, that blight should have appeared during the past season upon both the sprayed and unsprayed plants, but I was not prepared to find sulphur asserting its superiority over the copper compounds to a very marked degree. By the beginning of September however, the difference was apparent. The four half-rows sprayed with the copper compounds seemed to have experienced but little, if any, benefit; the two sprayed with potassium sulphide were in a better, but very far from satisfactory, condition; while those dusted with sulphur remained practically free from blight until they were boarded up late in September. The final treatment was made on Sept. 21st just before the plants were boarded up. On Oct. 11th the rows were opened and the plants examined very critically. No difference could be observed between the check plants and those treated with either of the copper compounds. In the case of the Bordeaux mixture it could be seen that the fungus was growing and fruiting luxuriantly upon leaves almost completely coated with the fungicide. Only the rows treated with sulphur showed any benefit arising from the treatment; here the lower leaves, which it had been difficult to reach, had blighted considerably since the plants had been boarded up, but on the whole the plants were in an incomparably better condition than those not sprayed.

My own judgment in the matter was confirmed by the independent opinion of Mr. Atwater, based upon constant observation thoughout the season, to the effect that sulphur was the only fungicide worth considering as a preventive of celery-blight. The potassium sulphide at first seemed to be holding its own with the sulphur, but later it seemed to lose its efficacy, owing no doubt to its extreme solubility which rendered it liable to be washed from the leaves by the slightest shower. The sulphur adhered to the leaves with remarkable tenacity and is moreover cheap and easily applied.

As far, then, as remedial treatment in the field is concerned, sulphur applied as a dry powder seems to be superior to any of the other substances usually employed as fungicides. How it would act in checking the spread of the blight in the storage house could not be determined, as the celery was marketed before the approach of freezing weather.

In closing, growers of celery must be urged again to consider the fact that whatever be the value of fungicides, the modern method of level culture of celery is in itself conducive to blight. The exposure of the roots to every fluctuation of temperature and moisture must of necessity weaken the plants, while the method of blanching by means of boards, thus suddenly cutting off the free circulation of air and access of sunshine, condensing moisture about the plants and allowing the free dissemination of fungous spores, is in the highest degree conducive to disease and decay.

It is a well known fact that *etiolated*, that is to say blanched plants, are always more susceptible to unfavorable conditions than plants which retain their normal green color. In the case of celery the consumer demands a product as perfectly blanched as is possible. By careful selection this demand has in a measure been met by the production of yellow varieties. But these are noticeably more susceptible to blight than the more vigorous green varieties, and their susceptibility is further increased by the process of blanching. The result is a plant of a highly artificial constitution and requiring extreme care to preserve its health. In order to secure this result the blanching process should be carried on gradually from below upwards, as the plant grows, and the delicate roots should be protected at all times from fluctuations of temperature. These two conditions were met by the old method of trench culture, under which blight was rarely, if ever, destructive; if this method must be superseded by level culture, care must be taken to protect the roots by means of a mulch and to make the blanching process gradual by banking earth against the plants as they increase in size rather than by the use of boards after they have attained their growth.

ON THE CAUSE AND PREVENTION OF A FUNGOUS DISEASE OF THE APPLE.

By Wm. C. Sturgis.

During the autumn of 1896 there were sent to this Station numerous samples of R. I. Greenings and Newtown Pippins presenting a blotched appearance. The blotches are circular in outline, pale at first but later becoming sooty black and exhibit under a lens a radiating structure. Individual blotches measure from a quarter to half an inch in diameter, but in many cases they coalesce, covering the surface of the apple with a sooty coating. This fungous growth seems to attack the fruit late in the season and to be strictly confined to the surface, from which it can easily be rubbed; it does not therefore, produce any deep-seated injury nor does it seem to check the growth of the fruit, but it is most unsightly and in bad cases may, for this reason, render the fruit practically unmarketable. To diagnose this sooty growth as fungoid is a simple matter of observation, but to determine the systematic position of the fungus is difficult since, so far as my observation goes, it is absolutely sterile. I have for a year kept apples infested with it under conditions most favorable for its further development, but it has exhibited no tendency to produce fruit. It retains the appearance of a thin felt of dark brown interwoven threads radiating from a center. Specimens which have been kept for some time may exhibit a tendency on the part of the cells composing the central portion of a blotch to collect into small irregular heaps, but such heaps consist merely of modified vegetative cells and I have succeeded in finding no reproductive bodies of any description. This agrees with the observation of other investigators who seem to have had this fungus in mind. In 1831, L. D. deSchweinitz published under the name *Dothidea pomigena* the following description of a fungus which he found upon apples in Pennsylvania. "*Spots orbicular, loose,* (in texture?), (composed of) *a radiating network of very delicate black fibrils, for the most part sterile. Cells in the centre, aggregated, expanded, comparatively large. Spots hardly ever* ¼ *inch* (in diameter). *Common on ripe apples known as 'Newton Pippins,' Pennsylvania.*" As far as outward appearance goes this would seem to be the same as the fungus here in question, but Prof. Jones of the Vermont Station mentions a "spot disease" of Baldwin apples which from his description differs widely in appearance from the sooty disease and is yet ascribed by Ellis to *Dothidea pomigena*, so that it is impossible to say just what the fungus described by deSchweinitz was. Ellis must have seen the latter's original specimen, and presumably he compared with it the fungus noted by Jones. If they are identical, then the original description is far from accurate. My own opinion is that the sooty disease above described is probably identical with the fungus observed by deSchweinitz on Newtown pippins, and named by him *Dothidea pomigena*, and that Jones' fungus is something different.

How this sooty disease is propagated from year to year is a matter of considerable uncertainty. Many of the more minute fungi which cause a diseased condition of flowering plants produce normally three distinct forms of reproductive bodies; first, spores born exposed to the air upon more or less specialized branches of the vegetative threads and called *conidia*; secondly, minute bodies born upon stalks enclosed in a receptacle and called *pycnospores*; and finally, large and more highly developed spores which are born in specialized sacs (*asci*) enclosed in a receptacle similar to that containing the pyconospores; these are known as *ascospores*. But comparatively few of these fungi produce all three forms of spores; in their long course of development one or more of the forms has become suppressed. Thus the fungus of celery-blight produces only one form of spore, the fungus of apple-scab, long supposed to produce only conidia, is now known to produce ascospores as well, and so on. But in certain fungi whose organs of reproduction consist only of conidia, the latter are of such a simple type as to be hardly distinguishable from small portions of the vegetative threads; such is the fungus which causes potato-scab. From this it is only a step to a condition wherein certain portions of the purely vegetative threads become slightly differentiated and serve the purpose of propagation. It seems probable that such is the case with the sooty fungus above described. The modified vegetative cells composing the irregular heaps mentioned as occupying the centre of the blotches, are easily detached from the surface of the apple in the form of dark-brown oval bodies, sometimes unicellular, but more often composed of two or more united cells. Natural causes are sufficient to bring about the dissemination of these bodies, as is seen by the fact that apples completely infested by the fungus, after exposure to the weather for nine months, show only the faintest trace of the original fungous spots, the bulk of the fungus having been weathered off. It is hoped that further investigation may throw more light upon the method by which this fungus is propagated and either prove or disprove conclusively the theory that it is by means of modified vegetative cells which become detached from the surface of the fruit and are carried thence by natural agencies to the young fruit of the succeeding season.

Meantime it is fairly self-evident that wind-falls and infested fruit remaining on the trees at harvest-time should be gathered and either buried or burned.

The superficial habit of this fungus is an indication that it can be readily controlled by the use of fungicides. To test this matter, a block of R. I. Greening trees in the orchard of Mr. N. S. Platt of Cheshire, was selected for an experiment with Bordeaux mixture. Three of the trees were left without treatment to serve as checks; the remainder were treated on April 27th with a solution consisting of one pound of copper sulphate to twenty-five gallons of water, in order to destroy any fungous germs then present on them. This was followed by treatment with Bordeaux mixture made according to the formula 6–4–50 and applied on May 10th, 17th, and 28th, and June 14th. For the first three applications half a pound of Paris green was added to every fifty gallons of the Bordeaux mixture in order to prevent damage from the canker worm, which was unusually abundant and destructive. In passing, it may be noted that this treatment with Paris green was thoroughly efficacious, the sprayed trees remaining practically free from worms while the foliage of the check trees was seriously damaged and that of neighboring orchards was completely destroyed. Unfortunately the pressure of other work made it necessary to spray these trees when we could, rather than when it was most advisable. Thus one of the applications had to be made while some of the trees were still in almost full bloom and this undoubtedly diminished the crop, though other causes combined to bring about this result. It would also have been advisable to give at least one application after July 1st, since, according to my observation, the sooty fungus develops and spreads most rapidly late in the season; but this was impracticable. Nevertheless the results of the experiment are of interest. The general vigor of the sprayed trees was far superior to that of the checks; as already noted, the spraying served to reduce to a minimum the injury from the canker worm; and the quality of the fruit was greatly improved. In order to see whether the fungus would increase upon stored fruit already showing the characteristic blotches, and also whether it would develop upon fruit free from it at the time of picking, I tried to select for storage half a bushel each of blotched and clean fruit from a sprayed and an unsprayed tree. It is an evidence of the beneficial result of spraying that from the check tree selected it was impossible to pick out the desired quantity of clean fruit, while from a sprayed tree, which produced a much larger crop than any of the check-trees, the reverse was true and most of the apples selected as being blotched showed only very slight traces of the fungus. The apples so selected were packed in baskets on Oct. 4th and stored in a fairly cool, dry cellar. They were examined on Nov. 5th and again on Nov. 30th. On neither occasion was there any sign that the fungus had increased upon the blotched fruit or had spread to the clean fruit, but the contrast in keeping quality between the sprayed and the unsprayed apples was very remarkable, as may be seen from the following table.

A represents blotched apples from an unsprayed tree.*
B " clean " " a sprayed tree.
C " blotched " " a sprayed tree.

		A.†	B.	C.
Nov. 5th	Sound apples	45	62	38
	Decayed apples	28	7	16
Nov. 30th	Sound apples	25	52	21
	Decayed apples	20	10	17

* A sufficient quantity of clean fruit could not be selected from these trees.

† The baskets being all of the same size and completely filled, the number of apples in each basket is an indication of the comparative size of the apples. A, has the largest number and therefore the smallest apples.

This shows that of the apples from the unsprayed tree (A), 66 per cent. decayed within two months of harvest, while of the apples from the sprayed tree (B), only 25 per cent. decayed within the same period, or an average of 43 per cent. from the two sprayed trees.

There is no question but that Bordeaux mixture applied at intervals of about two weeks from the middle of June until the middle of August will effectually prevent the occurrence of this sooty fungus. Although in this neighborhood the fungus in question occurs principally on R. I. Greenings, it has been found, as noted above, on Newtown Pippins in Pennsylvania. Profs. Green and Selby note its occurrence in Ohio on Peck's Pleasant and Rome Beauty as well as on certain varieties of pears, notably Vicar and Angoulême. Prof. Lamson of New Hampshire finds it common on Greenings, Northern Spies, Baldwins and "many other varieties," and on pears of the Beurré d' Anjou and Lawrence varieties.

Under favorable conditions the sooty fungus will probably attack most varieties of apples and pears, but all observers agree in stating that it may be controlled by the use of Bordeaux mixture.

PRELIMINARY INVESTIGATIONS ON A DISEASE OF CARNATIONS.

By Wm. C. Sturgis.

Last January it was noticed that carnations of the variety William Scott, grown in the Station greenhouse, were showing symptoms of a diseased condition. The plants formed part of an experiment with fertilizers and were grown partly in a mixture of coal-ashes and moss-peat, and partly in rich garden compost, as described elsewhere in this report. The disease appeared first as a yellowing of the lower leaves which later became dry and dead, but as the disease progressed the whole plant became involved until finally death ensued. There was no sudden wilting of the plants in connection with the trouble, but those affected resembled plants from which the water or food-supply was being gradually withdrawn.

In rare instances, where only a portion of a plant appeared affected, the removal of that portion resulted in checking the progress of the trouble, but, as a rule, the appearance of the first symptoms indicated the death of the plant sooner or later.

Inquiry among neighboring carnation growers showed that this trouble, commonly known as "die-back" or "stem-rot," was frequently the cause of great loss and that certain varieties, notably the one above mentioned, appeared to be peculiarly susceptible to it, but no one was prepared to hazard a conjecture as to its cause.

Examination failed to disclose the presence of any fungus upon the dead or dying leaves, red spiders and aphides were equally abundant at times upon both the diseased and the sound plants, and the roots of the diseased plants appeared to be fairly sound. In all cases however, the stalk of the dying plants presented a peculiar appearance just below the surface of the ground. The outer layers at this point were discolored and disintegrated and the cambium cells were partially destroyed, while permeating the wood and collecting in masses in the larger vessels and ducts was a fungous mycelium consisting of very delicate colorless threads. Its habit of growth at once called to mind the disease of watermelons, known as "wilt" and ascribed by Prof. E. F. Smith to a fungus of the genus *Fusarium*. By inoculating culture tubes with bits of the fungus-infested tissue from diseased stems, it was a comparatively simple matter to secure pure cultures of the mycelium.

Meanwhile, careful search was made for the spores of the fungus in order that its systematic position might be determined. Finally, at the base of a plant which had died of the trouble but had been allowed to remain in the bench, there was observed a delicate web with a pinkish coloration. This proved to be a mycelium identical in appearance with that occurring within the tissues, but covered with colorless spores, rather long, curved, pointed at both ends and divided by cross-partitions into a number of cells. Such spores characterize the genus *Fusarium*. A comparison of these spores with those shortly produced in abundance on the mycelium growing in the culture tubes, showed that the two were identical. A little later the same fungus was found growing and fruiting luxuriantly upon the woody tissues exposed by the removal, from an otherwise sound plant, of a badly diseased branch. A quantity of culture-tubes were inoculated with spores from all of these sources and kept for future use.

Attempts were first made to reproduce the diseased condition by injecting the *Fusarium* spores into incisions made in various portions of healthy plants. This method failed in every case, and it was finally concluded either that the fungus had no causal connection with the disease or that infection must take place beneath the surface of the soil. In order to get more light on this matter the following course was pursued.

Two lots each of compost and the ashes and peat mixture were prepared ; one of them was thoroughly sterilized, the other not.

The sterilized and non-sterilized soils were again divided into two lots, one of which was thoroughly infected with the *Fusarium* by shaking up a pure culture of the fungus with sterilized water and mixing it with the soil, while the other was left without infection.

By this means a great variety of conditions was secured. These conditions are represented in the following table.

Garden Compost. (Loam 2 parts, Barnyard Manure 1 part.)	Sterilized	Infected	Pot 13. S. Pot 14. F.
		Not infected	Pot 7. S. Pot 8. F.
	Not Sterilized	Infected	Pot 9. S. Pot 10. F.
		Not infected	Pot 1. S. Pot 2. F.
Ash Soil. (Coal Ashes 97 parts, Moss peat 3 parts.)	Sterilized	Infected	Pot 15. S. Pot 16. F.
		Not infected	Pot 5. S. Pot 6. F.
	Not Sterilized	Infected	Pot 11. S. Pot 12. F.
		Not infected	Pot 3. S. Pot 4. F.

From the above table it will be seen that sixteen plants were grown, the origin of each plant being indicated by the letter S or F.

S, signifies that the plant so marked was a cutting taken from a plant grown at the Station and apparently free from disease; F, that the cutting was supplied by a neighboring grower.

The plants raised by this grower had previously suffered severely from the disease and by the time the cuttings reached us they were already rooted in earth and there was no means of discovering the condition of the plants from which they had been taken. There was therefore, a possibility that the fungus was already in the tissues of the cuttings when they were received. Similar uncertainty prevailed in the case of our own cuttings, since they were made before the experiment was planned and sufficient care was not taken to ascertain that the plants from which they were taken were free from disease; but, as above noted, the plants were apparently sound and the cuttings had been rooted in clean sand. This uncertainty regarding the condition of the cuttings rendered the results untrustworthy; nevertheless the experiment was not wholly without value.

Before the cuttings were potted the roots were carefully washed in distilled water and the pots were thoroughly rinsed in a saturated solution of copper sulphate. The cuttings were then potted according to the table on p. 177, and the pots plunged in a bed of coal ashes and moss peat in the greenhouse. In order to avoid contamination during the growing period, the plants in the ash soil were watered with soluble plant-food prepared according to Wagner's formula, and those in the compost with pure water distilled or filtered.

The soil in which the pots were plunged was kept damp and this led to over-watering of the pots, so that some of the plants undoubtedly died of too much moisture at the roots. Some general points of interest were noted during the course of the experiment. First, the plants grown in the coal ashes and moss peat were decidedly more healthly than those grown in the compost. In the former, five of the eight plants remained sound and vigorous up to the close of the experiment; in the latter, only three.

Secondly, comparing the home-grown plants with those of the series F, five plants of the former (three in the compost and two in the ash soil) remained vigorous; of the latter, only two in the ash soil.

Thirdly, as to the condition of the dead plants as shown by microscopic examination: of the four in the compost which were dead by Aug. 1st, No. 13 showed *Fusarium* spores near the surface of the soil and some mycelium in the outer tissues; No. 14 showed an abundance of mycelium permeating the stem, clogging the vessels and producing quantities of spores at the surface of the soil; (both of these plants were grown in sterilized compost infected with the fungus); No. 2 (grown in compost neither sterilized nor infected) showed no trace of the fungus, but the tissues of the roots were decayed and infested with nematodes, indicating over-watering; No. 8 (grown in compost sterilized but not infected) showed a similar condition of the roots, but at the same time the *Fusarium* was found fruiting abundantly on the base of the plant. In this case it is probable that the fungus was in the tissues of the original cutting, since every care had been taken to prevent infection from the outside.

Of the three diseased plants in the ash-soil, No. 15, which was subjected to artificial infection through the soil, showed the presence of the *Fusarium* at the base of the lower leaves but not to a very serious extent; No. 16, subjected to the same conditions as No. 15, showed no fungus, but the roots were infested with nematodes and so far decayed that it was impossible to say with certainty whether or not the *Fusarium* was present. No. 6 (grown in ash-soil sterilized but not infected) showed the *Fusarium* fruiting abundantly on the base of the plant. Here again it is difficult to attribute the outbreak of the fungus to any other cause than its presence in the tissues of the original cutting, and it is interesting to note that in both cases (Nos. 8 and 6) where a decided outbreak of the *Fusarium*, followed by the death of the plant, took place in sterilized soil not subjected to artificial infection, the cuttings came from a locality infested with the fungus and were rooted in compost from the same locality. Most of the other cases where the fungus was found on or in the plants, were those in which the soil had been purposely infected with spores from pure cultures of the *Fusarium*.

In closing, a few words may be added regarding the nature of this fungus itself. In 1892, Atkinson* described a disease of cotton and okra plants which he attributed to *Fusarium vasinfectum*, Atk., assisted possibly by a previous attack of the damping off fungus or of bacteria. He describes this fungus as "in some cases completely filling the vascular channels of the plant." There does not seem to be any sudden wilting of the plant in connection with this trouble, but a gradual change in the color of the leaf suggestive of premature ripening, followed by death. In general habit and in the character of the spores this fungus seems to be almost identical with that occurring in carnations. In 1895, Massee† described, under the name "sleepy disease," a disease of tomatoes which he attributes to *Fusarium Lycopersici*, Sacc. In this case the first symptom of the trouble is a sudden drooping of the leaves; this is followed by their discoloration, and, on splitting open the stem, the woody tissue is found to be yellowish-brown in color, while the mycelium of the *Fusarium* is observed occupying the vessels of the stem and passing upward to the leaves. This fungus produces two forms of spores, one of which seems to agree fairly well with the carnation-fungus in question, though I have not seen Massee's original description.

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* Ala Agric'l. Exper't. Sta. Bull. 41, pp. 19–29.

† Gard. Chron., Ser. 3, xvii, No. 441, pp. 707 & 708. Cf. also Exp. Sta. Rec. vii-3, p. 222. (1895.)

Finally, Smith* has studied exhaustively a "wilt" of watermelon and other plants which he attributes to an apparently undescribed fungus named by him *Fusarium niveum.* The trouble is characterized by the sudden wilting of the plants affected and by the constant presence of the fungus "in the water-ducts of the stem, filling them more or less completely and interfering with the movement of water from roots to foliage." Three forms of spores are described as characterizing this fungus, one of which is at least very similar to the spores produced by the carnation-fungus; the same fungus is noted as causing a "wilt" of sweet-potatoes, cabbage and cow-pea; its probable identity with the fungus of Atkinson's cotton and okra wilt is noted, and finally it is stated as probable that the ascosporic form of the fungus has been discovered in *Nectriella tracheiphila*, a species hitherto undescribed. A full account of this matter is promised as a publication of the U. S. Department of Agriculture, but so far as I am aware, it has not yet appeared.

Returning to the carnation-fungus, there seems a strong probability that it may prove identical with that described by Smith and Atkinson. As yet however, only one form of spore has been seen, a spindle-shaped or *fusiform* spore, pointed at both ends, hyaline, slightly curved, 3–5-septate and measuring 25–38$\mu \times$3.5–4μ. These spores are borne singly or in small clusters on the tips or sides of short branches of the mycellium and, when seen in the mass, present a pale salmon-pink color. One peculiarity was noticed in connection with their germination. When perfectly fresh and abundantly supplied with food and moisture, they may produce germ-tubes from any or all of the cells; but in old cultures or when the conditions are unfavorable to germination, the contents of the spore coalesce in the form of one or two spherical, thick-walled bodies, slightly larger than the original diameter of the spore and having every appearance of resting-spores. At first sight the original spore seems to have completely disappeared, but closer examination shows the empty and almost transparent spore-wall still intact and attached to the spherical bodies. The latter, when again placed under favorable conditions, germinate and give rise to a mycelium bearing the ordinary *Fusarium* spores. The production of these thick-walled resistant spores may be a fact of considerable importance in the economy of this fungus.

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* Proc. Am. Asso. Adv. Sc., XLIII, pp. 289 & 290 (1894); also XLIV, p. 190. (1895.)

Summary and Conclusions.

The disease of carnations commonly known as "die-back" and "stem-rot," seems to be due to a fungus which gains access, in some way not fully determined, to the tissues at or just below the surface of the soil, and accumulates in the water-ducts of the stem, thus preventing the free transfer of water upwards.

There is a strong probability that the disease may be propagated by means of the vegetative threads of the fungus existing in cuttings taken from diseased plants. Cuttings should therefore be made only from sound plants.

The spores of the fungus are apparently able to retain their vitality for several months and to live over winter in the earth. The fact that the disease can be transferred to sound cuttings by planting the same in soil containing vegetable matter and impregnated with the spores of the fungus, indicates that the spores can thrive in such soil and thence gain access to the tissues of the plant. Consequently when the disease has been present in the greenhouse the old soil should be completely removed, the house thoroughly fumigated with sulphur and the benches refilled with fresh soil. Abundant moisture and an excess of vegetable matter in the soil afford conditions favorable to the development of the *Fusarium*. These should therefore be avoided, as far as possible.

Where practicable, sterilizing the soil by means of steam or hot air would be effective in preventing the attacks of the fungus. In this case diseased cuttings would be the only possible cause of contamination.

Certain varieties are much more susceptible than others. Care should therefore be taken in the selection of varieties. William Scott seems to be one of the most susceptible.

Inasmuch as the production of the *Fusarium*-spores, and hence the rapid dissemination of the disease, takes place only at a considerable interval after the first symptoms of the disease appear, the immediate removal and destruction of plants showing these symptoms is to be strongly recommended.

LITERATURE OF FUNGOUS DISEASES.*

By W. C. Sturgis.

A PROVISIONAL BIBLIOGRAPHY OF THE MORE IMPORTANT WORKS PUBLISHED BY THE U. S. DEPARTMENT OF AGRICULTURE AND THE AGRICULTURAL EXPERIMENT STATIONS OF THE UNITED STATES FROM 1887 TO 1897 INCLUSIVE, ON FUNGOUS AND BACTERIAL DISEASES OF ECONOMIC PLANTS.

The substance of the following pages was originally published in 1893 as Bulletin 118 of this Station. The edition was exhausted before the demand for it had ceased and it was therefore republished in our Seventeenth Annual Report. Since that time the subject of fungous diseases of plants has received increasing attention on the part of mycologists and much of the earlier work has been superseded by the results of more accurate observations. This has detracted from whatever value the above-mentioned Bulletin may have had, and again there is a need for a concise bibliography, limited in its scope and bringing the subject up to date. The following work has been compiled from the earlier work and from my own notes made during the past four years.

General scope and plan of this Paper.—The determination of a fungus which is the cause of a specific disease of any economic plant is of course a matter for the specialist alone, but there seems to be no reason why any intelligent man should not be able to recognize, within certain limits, the cause of a diseased condition of a certain plant, provided only that he be furnished with a list of all diseases to which that particular plant is liable, each disease being characterized by a common name more or less expressive of the effect which the agent of disease produces, or of some evident peculiarity of that agent whether vegetable or animal. It is solely with the fungous and bacterial parasites of economic plants that this bibliography has to do, and it has been thought advisable to give to the common names of the diseases recorded, a prominence which might serve to render the latter more readily recognizable.

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* Including diseases caused primarily by Bacteria.

Such recognition of a fungous disease being thus partially provided for, references are given to such publications as careful study has convinced me to be the best as regards the description and illustration of the cause or effect of the disease in question, and any line of treatment which has been tested. This will enable anyone who has access to agricultural libraries or to files of Station publications, to answer for himself many questions which at present he must refer to those who are better informed than himself.

In one direction I have departed somewhat from the plan of the original publication. A proper understanding of many fungous diseases is to be obtained only by consulting certain foreign publications and others which were not originally included in this bibliography. I have therefore included a number of such references in the present work. Whether or not this departure is a wise one is a question which experience alone can answer, but I have endeavored to make it of practical value by confining such references, first, to diseases common to this and other countries; secondly, to investigations of primary value alone; thirdly, to diseases of recognized importance abroad which may at any time be transported to this country; and fourthly, to publications most liable to be found in agricultural or scientific libraries. In selecting these references I have followed the same plan as that originally pursued, viz. the examination of every reference personally and the selection of those which seemed to me the best. In order to retain the original uniformity of the bibliography and not to add to the perplexity of those desiring information from American sources only, I have relegated all foreign and other references to a position at the end of the work and have referred to them in the body of the work only by numbers.

Apart from these references to general scientific publications the ground of this Bulletin has already been covered, notably by certain publications of the Department of Agriculture,—the Experiment Station Record published monthly and giving digests of all publications of the Department and of the Stations; a Card Catalogue of the literature of the Experiment Stations and kindred institutions; and Bulletin 15 of the Office of Experiment Stations, a Handbook of Experiment Station work consisting of a Popular Digest of the Publications of the Experiment Stations. It will be seen at once that these three sources of information have a very wide scope, an admirable feature in itself but one not altogether adapted to obviate the difficulties of reference which increase rapidly as the literature accumulates. It now frequently requires much labor to discover if a certain parasitic fungus of economic importance has been recorded in Station publications, if any definite line of treatment has been recommended, and if so, where and when. The consequence is that much work is likely to be repeated unnecessarily.

I have thought that by limiting the scope of this bibliography to diseases caused by fungi and bacteria alone, and broadly speaking, to the years 1887–1897, I might eliminate the danger of error incidental to a larger undertaking, and at the same time depend upon a careful and personal comparison of the available Station literature under each subject to enable me to select what seemed to be the best.

Arrangement of topics.—The general arrangement of the work needs little comment. The main subjects are the host-plants and these are arranged alphabetically; under the name of each host-plant are arranged, also alphabetically, the "common names" of the fungous diseases recorded as affecting the plant. References to descriptions and illustrations either of the fungus itself or of its effect upon the host-plant follow, and finally a line of treatment, if any has been recommended or tested, is referred to. All references are arranged chronologically under each of the subheadings,—*Description* and *Treatment.* The date of publication occupies the right-hand margin of the page. In the case of references to Annual Reports, the number of the Report is given, followed immediately by the year which it covers, and in the margin the date of publication for the sake of uniformity.

Occasionally I have referred in the body of the work to other than Station literature, viz., to Lamson-Scribner's "Fungous Diseases of the Grape and other Plants," and to "Garden and Forest." I have made these exceptions on the ground that both of these publications should be, and probably are, in every library of agriculture, and because the author of the former was for some time connected with the Department of Agriculture, and many of its best publications on economic mycology proceeded from him, while in the columns of Garden and Forest, there have appeared from time to time important notes upon fungous diseases by Station workers.

Wherever, as in the case of Black-Rot of Grapes or Scab of

Apple, a great number of admirable papers have issued from many Stations, I have aimed first to select the fullest and best, and then to select those from widely separated localities in order that some one of the original publications referred to may be accessible to as many observers as possible. This has compelled me to omit many references which might have been recorded, since I have thought it best not to record two of equal worth from adjacent States, in case it were possible to substitute for one of them a publication from a widely different locality.

Common names of fungous diseases.—A word must be said regarding the so-called "common names" selected. Many names such as Black-Knot, Black-Rot, Rust, etc., have made such an impression that, as in the case of flowering plants, it would be unwise to disregard them. In economic mycology however, we are met by a difficulty regarding common names which is not so evident in the nomenclature of flowering plants. In the latter case the common names represent what alone the plants are known by either locally or nationally outside of scientific circles, and they have arisen spontaneously from common observation. In economic mycology on the other hand, many of the "common names" have been invented by the mycologists themselves and most loosely applied. Such, it is true, has not always been the case; thus every one recognizes that the "Rusts" belong to one group of fungi which the botanist calls *Uredineæ,* although doubtless the name first arose among people who were quite ignorant of the cause, but who noticed the rusty color produced uniformly by the disease : so in the case of the "Smuts," a common name fitly given by observant people, although the fungi causing "Smut," all happen to belong to the natural group of the *Ustilagineæ.* In such cases the common name has originated spontaneously and is fairly satisfactory. It is at least natural. But who knows even what one of the great natural groups of fungi is designated by the term "Leaf-Blight" or "Leaf-Spot," "Stem-Rot" or "Mildew ?"

Where such confusion has necessarily arisen regarding common names given arbitrarily and with no definite plan or system, it is manifestly impossible to arrange them on any satisfactory lines, and it would be an impertinence for one observer to attempt all the desirable changes. Deeming it expedient, for the reasons explained, to make use of common names in the present paper, and to give them a decided prominence, I have endeavored to group them as far as possible in conformity with the natural scientific arrangement, and in doing so, have ventured to change only a few which seem to have been originally bestowed with the least imaginable forethought. Such changes have been made chiefly in those diseases of the leaves which have been indiscriminately called "Leaf-Blight" or "Leaf-Spot." The former of these terms I have, with few exceptions, confined to conidial fungous forms belonging to the group of *Hyphomycetes* and producing upon the leaves attacked indeterminate or effused areas which sometimes involve the whole leaf in a condition most aptly described by the term "Blight." The perithecial forms whether acigerous, pycinidial, or spermogonial, I have grouped together under the general term "Leaf-Spot," since the diseased area produced by such forms in the leaf-tissue are often circumscribed in outline, giving the leaf a spotted appearance, and not infrequently become separated from the leaf altogether, producing the appearance described as "shot-hole." That on this basis the same disease must at one time be called "Leaf-Blight" and later "Leaf-Spot," is very true, but it seems to be one of the lesser evils attending the use of common names. The term "Scab," I have limited to hyphomycetous fungi which produce upon either the leaves or fruit attacked determinate spots occupied by a dense growth of the fungus and more or less indurated, although here again I have thought it best to denominate as "Scab" certain fungi which may not produce any definite scabby appearance, but which nevertheless belong to genera such as *Fusicladium*, *Fusarium*, *Cladosporium* and the like, to which belong those fungi which were originally and aptly called "Scab-fungi." I have done this because it seems best to make these common names depend more upon scientific principles than upon some indefinite effect produced on the tissues of the host. Under the general term "Anthracnose," I have followed established precedent in including conidial forms belonging, with one exception, to the group of the *Melanconieæ*. That exception is the genus *Vermicularia*, in which, though grouped with the *Sphaeropsideæ*, forms are included in which the perithecium is obsolete and which therefore approach the genus *Colletotrichum*. In cases where hyphomycetous fungi related to those which cause "Leaf-Blight," attack fruit and produce a decided decay, I have thought best to speak of them as "Fruit-Mold," and in some cases where similar effects are produced upon the leaves, as "Leaf-Mold," it being doubtful in some of these instances whether the attack is of a truly parasitic nature or does not more nearly resemble the process by which any dead organic substance becomes "moldy."

Finally, I have followed established precedent in the use of common names wherever it seemed that the name so applied was one actually in common use, outside of scientific circles, to designate a specific disease of an economic plant. Such names I have not felt at liberty to change, although, upon a scientific basis, a change might appear both practicable and desirable. Such cases are the "White-Rust" (*Cystopus*) of the Beet, Cabbage, Radish and Turnip, the "Frenching" (*Fusarium*) of Cotton, the "Damping-off" (*Pythium*) of seedlings, "Plum pockets" (*Taphrina*), "Leaf-curl" (*Exoascus*) of Peach, etc.

It will be noted that the familiarly descriptive term "Rot" has been applied to a great number of fungous diseases, a slight degree of system and clearness being secured by some qualifying prefix indicating, where practicable, the portion attacked.

Nomenclature.—I have relied upon several sources for the scientific names which I have used. For the Phænogams I have followed Bailey's revised edition of Gray's Field, Forest and Garden Botany, and the Index Kewensis of Hooker and Jackson. For the fungi I have relied largely upon Farlow & Seymour's Provisional Host-Index of the Fungi of the United States.

Abbreviations.—Little need be said regarding the abbreviations used, since most of them are readily intelligible. Among the publications referred to, *Journ. Mycol.* stands for the *Journal of Mycology,* issued serially by the Department of Agriculture, Division of Vegetable Pathology; *Scribner, Fung. Dis.* refers to "*Fungous Diseases of the Grape and other Plants,*" by F. Lampson Scribner, published by the J. T. Lovett Company, Little Silver, N. J., 1890; and *Gar. and For.* refers to the horticultural journal "*Garden and Forest,*" published from the Tribune building, New York City. The two latter publications are occasionally referred to for reasons stated above.

The names of States are abbreviated according to the usual custom; *Bulletin* and *Report* are abbreviated respectively to *Bull.* and *Rep.*, and, as already explained are arranged chronologically accordingly to date of publication. Where two Stations exist in one State, they are distinguished by separate titles; thus *N. Y.* (*Corn. Univ.*) *Agr. Exp. Sta.*, refers to the Experiment Station connected with Cornell University at Ithaca, N. Y. The publications under the heading *U. S. Dept. Agr.*, and abbreviated to *Circ.* and *Farm. Bull.*, are occasional issues of the Department of Agriculture called *Circulars* and *Farmers Bulletins*, which give information of value to farmers and others in a simple and concise form.

The abbreviations which precede the references will require more extended explanation. *Descr.*, indicates that in the work referred to, the fungus or its effect on the plant has been described; if followed by *Illus.*, the fungus or its effect has also been illustrated. *Occ.*, indicates that the occurrence of the fungus has been noted, with no further comment. *Treat.*, stands for Treatment, the abbreviation in parenthesis which follows being explanatory; (*rec.*), indicates that a definite line of treatment has been recommended, though based upon analogy and not upon any direct experiment; (*pos.*), that a positive line of treatment has been proved successful by definite experiments the results of which are recorded; (*neg.*), either that some treatment has been tried and has given negative results, or that nothing has yet been attempted in this direction. It may be well to note that *Cf*, the usual abbreviation of *Compare*, refers the reader to some other portion of the paper for further information.

In preparing this article for publication I am only too conscious that critical eyes will detect many errors and omissions. I have attempted to include only the best publications of permanent value relative to fungous diseases which have issued from the Department of Agriculture and the Agricultural Experiment Stations, between and including the years 1887 and 1897, though I have not always limited myself to those dates. Many will doubtless dissent from my judgment in the selection of papers as worthy of record; such critics I would ask kindly to inform me of any such errors or omissions in order that they may be corrected if possible and advisable.

New Haven, December, 1897.

Alfalfa.

(*Medicago sativa*, L.)

Leaf- Spot (*Pseudopeziza Medicaginis*, (Lib.) Sacc.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 3, 1890, pp. 79–82. (1891)
Treat. (rec.), Del. Agr. Exp. Sta., Rep. 3, 1890, p. 82. (1891)
Root-Rot (*Ozonium auricomum*, Lk.)
Occ., Tex. Agr. Exp. Sta., Bull. 22. (1892)
Cf., Cotton (Root-Rot).

Almond.

(*Prunus* (*Amygdalus*) *communis*, L.)

Anthracnose (*Glœosporium amygdalinum*, Briz.) (1)
Leaf-Blight (*Cercospora circumscissa*, Sacc.)
Descr. Illus., Journ. Mycol., Vol. VII, pp. 66–76. (1892)
Treat. (pos.), Journ. Mycol., Vol. VII, pp. 232–239. (1893)

Apple.

(*Pirus malus*, L.)

Anthracnose or Ripe-Rot (*Glœosporium fructigenum*, Berk.)
Descr. Illus., Journ. Mycol., Vol. VI, p. 164. (1891)
Va. Agr. Exp. Sta., Bull. 40, pp. 59–70. (1894)
Treat. (pos.), Journ. Mycol., Vol. VI, p. 172. (1891)
Cf. Grape (Ripe-Rot) Ky. Agr. Exp. Sta., Bull. 44. pp. 20–22. (1893)
Cf. N. J. Agr. Exp. St., Rep. 13, 1892, pp. 326–333.
Black-Rot (*Sphœropsis Malorum*, Berk.)
Descr., Scribner, Fung. Dis., p. 81. (1890)
Descr. Illus., R. I. Agr. Exp. Sta., Rep. 7, 1894, pp. 192 & 193. (1895)
Treat. (pos.), Ky. Agr. Exp. Sta., Bull. 59, pp. 122–125. (1895)
Cf. Quince (Black-Rot).
Fire-Blight (*Bacillus amylovorus*, (Burrill).)
Descr., Colo. Agr. Exp. Sta., Rep. 1, 1888, pp. 64–69. (1888)
Conn. Agr. Exp. Sta., Rep. 18, 1894, pp. 113–117. (1895)
Treat. (rec.), Colo. Agr. Exp. Sta., Rep. 1, 1888, p. 68. (1888)
Conn. Agr. Exp. Sta., Rep. 18, 1894, p. 116. (1895)
Susceptible varieties. Gar. & For., Vol. IX, p. 467. (1896)
Cf. Pear (Fire-Blight).
Fly-Speck (*Leptothyrium Pomi*, (Mont. & Fr.) Sacc.)
Descr., Gar. & For., Vol. IX, pp. 474 & 475. (1896)
Descr. Illus., Ohio Agr. Exp. Sta., Bull. 79, pp. 133 & 134. (1897)
Fruit-Spot (*Phyllachora pomigena*, (Schw.) Sacc.)? (2)
Descr., Vt. Agr. Exp. Sta., Rep. 5, 1891, p. 133. (1892)
Treat. (pos.), N. H. Agr. Exp. Sta., Bull. 45, pp. 46 & 47. (1897)

Leaf-Spot (*Phyllosticta pirina*, Sacc.)
Descr. Illus., R. I. Agr. Exp. Sta., Rep. 7, 1894, pp. 188 & 189. (1895)
Treat. (rec.), R. I. Agr. Exp. Sta., Rep. 7, 1894, p. 191. (1895)
Leaf-Spot (*Phyllosticta limitata*, Pk.)
Descr., N. Y. Agr. Exp. Sta., Rep. 14, 1895, p. 545. (1896)
Treat. (rec.), N. Y. Agr. Exp. Sta., Rep. 14, 1895, p. 546. (1896)
Powdery-Mildew { (*Podosphaera oxyacanthae*, (DC.), DBy.)
(*Sphærotheca Mali* (Duby) Burr.)
Descr., Iowa Agr. Exp. Sta., Bull. 23, pp. 921 & 922. (1894)
Treat. (pos.), U. S. Dep. Agr., Sec. Veg. Path., Circ. 8, p. 8. (1889)
Rust (*Gymnosporangium spp.* Syn. *Rœstelia spp.*)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 370-378. (1889)
Del. Agr. Exp. Sta., Rep. 8, pp. 63-69. (1896)
Treat. (pos.), U. S. Dep. Agr., Rep. for 1888, p. 379. (1889)
Cf. Conn. Agr. Exp. Sta., Bull. 107.
Scab (*Fusicladium dendriticum*, (Wallr.) Fckl.) (3)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, p. 341. (1888)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 84, pp. 10-15. (1895)
Treat. (pos.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 60, pp. 257-279. (1893)
Wis. Agr. Exp. Sta., Rep. 10, pp. 230-240. (1893)
Ark. Agr. Exp. Sta., Bull. 26, pp. 24-33. (1894)
Mo. Agr. Exp. Sta., Bull. 27. (1894)
Vt. Agr. Exp. Sta., Rep. 8, 1894, pp. 109-113. (1895)
Del. Agr. Exp. Sta., Bull. 29, pp. 18-24. (1895)

Apricot.

(*Prunus Armeniaca*, L.)

Leaf-Spot (*Septoria cerasina*, Pk.) (4)

Artichoke.

(*Cynara Cardunculus*, L.)

Leaf-Blight (*Ramularia Cynaræ*, Sacc.) (5)

Asparagus.

(*Asparagus officinalis*, L.)

Anthracnose (*Colletotrichum*, *sp.*)
Occ., N. J. Agr. Exp. Sta., Rep. 17, 1896, p. 410. (1897)
Blight (*Cercospora Asparagi*, Sacc.)
Occ., U. S. Dep. Agr., Farm. Bull. 61, p. 34. (1897)
Rust (*Puccinia Asparagi*, D. C.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 17, 1896, pp. 407-410. (1897)
Conn. Agr. Exp. Sta., Rep. 20, 1896, pp. 281 & 282. (1897)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 17, 1896, p. 408. (1897)
U. S. Dep. Agr., Farm. Bull. 61, pp. 32 & 33. (1897)

Aster (China).

(*Callistephus hortensis*, Cass.)

Wilt (*Fusarium sp.*)
Descr., Amer. Gardening, XVI-86, p. 518. (1896)
Treat. (rec.), Amer. Gardening, XVII-86, p. 518. (1896)

Barley. (6)

(*Hordeum sp.*)

Ergot (*Claviceps purpurea*, Tul.)
See Rye (Ergot).
Leaf-Blight (*Scolecotrichum graminis*, Fckl., and *Helminthosporium graminis*, Rab.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1886, p. 129. (1887)
Descr., Journ. Mycol., Vol. VII, pp. 96 & 97. (1892)
Mold (*Hormodendron Hordei*, Bruhne). (7)
Rust (*Puccinia graminis*, P. and *P. Rubigo-vera*, (DC.) Wint.)
See Oats and Wheat (Rust).
Smut (*Ustilago Hordei*, (P.) Kell. & Sw., and *U. nuda*, (Jens.) Kell. & Sw.)
Descr. Illus., Kan. Agr. Exp. Sta., Rep. 2, 1889, pp. 268–283. (1890)
Mass. Agr. Exp. Sta., Rep. 9, 1891, pp. 244–246. (1892)
Tr. (pos.), N. Dak. Agr. Exp. Sta., Bull. 27, p. 161. (1897)
Smut (*Ustilago medians*, Biedenkopf). (8)
Cf. Oats and Wheat (Smut).

Bean.

(*Phaseolus vulgaris*, L.; *P. lunatus*, L., &c.)

Anthracnose (*Colletotrichum Lindemuthianum*, (Sacc. & Magn.) Bri. & Cav.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, p. 361. (1888)
N. Y. Agr. Exp. Sta., Bull. 48, pp. 310 & 318. (1892)
Me. Agr. Exp. Sta., Rep. 1893, p. 152. (1894)
Treat. (pos.), N. Y. Agr. Exp. Sta., Bull. 48, pp. 312–317. (1892)
N. J. Agr. Exp. Sta., Bull. 108, p. 30. (1895)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 326–333.
Blight (Bacterial).
Descr. Illus., N. Y. Agr. Exp. Sta., Bull. 48, pp. 329–331. (1892)
N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 283. (1893)
Treat. (pos.), N. J. Agr. Exp. Sta., Bull. 108, pp. 24–30. (1895)
N. J. Agr. Exp. Sta., Rep. 17, 1896, pp. 328–333. (1897)
Cf. Bot. Gaz., XXIV-3, p. 192. (1897)
Downy Mildew (*Phytophthora Phaseoli*, Thaxter).
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 167–170. (1890)
Treat. (pos.), Conn. Agr. Exp. Sta., Rep. 21, 1897, pp. 162–166. (1898)
Leaf-Spot (*Phyllosticta* sp.)
Descr., N. J. Agr. Exp. Sta , Rep. 12 1891, p. 287. (1892)
Powdery Mildew (*Erysiphe Martii*, Lév.)
Treat. (pos.), Journ. Mycol., Vol. V, p. 214. (1889)
Rust (*Uromyces appendiculatus*, (P.) Lév.)
Descr. Illus., N. Y. Agr. Exp. Sta., Bull. 48, p. 331. (1892)
Treat. (neg.), N. Y. Agr. Exp. Sta., Bull. 48, p. 333. (1892)

Beet.

(*Beta vulgaris*, L.)

- Bacteriosis (*Bacillus* sp.) (9)
- Blight (Bacterial).
  - Descr., Ind. Agr. Exp. Sta., Bull. 39, pp. 54–58. (10) (1892)
- Gummosis (Bacterial). (11)
- Heart-Rot (*Phoma Betæ*, Frank). (12)
- Leaf-Blight (*Cercospora beticola*, Sacc.)
  - Descr. Illus., Iowa Agr. Exp. Sta., Bull. 15, pp. 239–242. (1891)
  - Treat. (pos.), N. J. Agr. Exp. Sta., Bull. 107, pp. 8–11. (1895)
- Root-Rot (*Rhizoctonia Betæ*, Kühn).
  - Descr. Illus., Iowa Agr. Exp. Sta., Bull. 15, pp. 244–248. (1891)
  - Treat. (rec.), Iowa Agr. Exp. Sta., Bull. 15, p. 250. (1891)

- Root-Rot (*Phyllosticta* sp.) (13)
  - Descr. Illus., N. J. Agr. Exp. Sta., Bull. 107, pp. 4–6. (1895)
  - Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 107, p. 6. (1895)
- Rust (*Uromyces Betae*, (P.) Kühn).
  - Descr. Illus., U. S. Dep. Agr., Rep. for 1887, p. 350. (1888)
  - Descr., Iowa Agr. Exp. Sta., Bull. 15, p. 235. (1891)
  - Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 353. (1888)
    - Iowa Agr. Exp. Sta., Bull. 15, p. 236. (1891)
- Scab (*Oospora scabies*, Thaxter).
  - Descr. Illus., Ind. Agr. Exp., Bull. 39, pp. 58–60. (1892)
  - Treat. (rec.), Ind. Agr. Exp. Sta., Bull. 39, p. 60. (1892)
  - Cf. Conn. Agr. Exp. Sta., Rep. 20, 1896, p. 266.
  - Cf. Potato (Scab).
- Smut
  - (*Oedomyces lephroides*, (Trabut) Sacc.) (14)
  - (*Cladochytrium pulposum*, Vuil.) (15)
- White-Rust (*Cystopus Bliti*, (Biv.) Lév.)
  - Descr. Illus., Iowa Agr. Exp. Sta., Bull. 15, pp. 237 & 238. (1891)

Blackberry.

(*Rubus villosus*, Ait. *vars.*)

- Anthracnose (*Glœosporium Venetum*, Speg.)
  - See Raspberry (Anthracnose).
- Blight (Bacterial).
  - See Raspberry (Blight).
- Leaf-Spot (*Septoria Rubi*, Westd.)
  - Descr., Ohio Agr. Exp. Sta., Bull. IV–6, p. 126. (1891)
  - Treat. (neg.), Jour. Mycol., Vol. VII, p. 22. (1891)
- Rust (*Cœoma* (*Uredo*) *luminatum*, Lk.; Syn. *Puccinia Peckiana*, Howe.)
  - Descr. Illus., Ill. Agr. Exp. Sta., Bull. 29, pp. 273-286. (1893)
  - Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 224. (1891)
- White Rust (*Chrysomyxa albida*, Kühn.)
  - Descr. Occ., Mass. (Hatch.) Agr. Exp. Sta., Rep. 9, 1896, p. 74. (1897)

Broom-Corn.

(See Sorghum.)

Buckwheat.

(*Fagopyrum esculentum*, Mœnch.)

Leaf-Blight (*Ramularia rufomaculans*, Pk.)
Descr., Conn. Agr. Exp. Sta., Rep. 14, 1890, p. 98. (1891)
Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 14, 1890, p. 98. (1891)

Cabbage.

(*Brassica oleracea*, L.)

Brown-Rot (*Pseudomonas campestris*, (Pammel) Smith).
See Turnip (Brown-Rot).
Club-Root (*Plasmodiophora Brassicæ*, Wor.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 98. (1893)
Treat. (pos.), N. J. Agr. Exp. Sta., Bull. 108, pp. 14–18. (1895)
N. Y. Agr. Exp. Sta., Rep. 14, 1895, pp. 525–529. (1896)
Downy Mildew (*Peronospora parasitica*, (P.) Tul.
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 349. (1891)
N. C. Agr. Exp. Sta., Bull. 84, p. 15. (1892)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 84, p. 15. (1892)
Leaf-Blight (*Macrosporium Brassicæ*, Berk.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 349. (1891)
Leaf-Rot (Bacterial). (16)
Cf. Turnip (Brown-Rot).
Powdery Mildew (*Oidium Balsamii*, Mont.)
See Turnip (Powdery Mildew).
Rot (Bacterial).
Descr., Ky. Agr. Exp. Sta., Rep. 3, 1890, pp. 43–46. (1894)
White Rust (*Cystopus candidus*, (P.) Lév.)
Occ., N. C. Agr. Exp. Sta., Bull. 84, p. 15. (1892)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 84, p. 15. (1892)

Carnation. (17)

(*Dianthus Caryophyllus*, L.)

Anthracnose (*Colletotrichum* sp.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 301. (1892)
Anthracnose, (*Volutella Dianthi*, Atkins.)
Descr., N. J. Agr. Exp. Sta., Rep. 14, 1893, pp. 385 & 386. (1894)
Bacteriosis (*Bacterium Dianthi*, Arth. & Boll.) (18)
Descr. Illus., Ind. Agr. Exp. Sta., Bull. 59, pp. 17-34. (1896)
Treat., Ind. Agr. Exp. Sta., Bull. 59, pp. 34–37. (1896)
Leaf-Blight, (*Alternaria*, sp.) (19)
Leaf-Mold (*Heterosporium echinulatum*, (Berk.) Cke.) (20)
Occ., N. J. Agr. Exp. Sta., Rep. 14, 1893, p. 386. (1894)

Leaf-Spot (*Septoria Dianthi*, Desm.)
Descr., N. J. Agr. Exp. Sta., Rep. 14, 1893, pp. 384 & 385. (1894)
Treat. (pos.), N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 363. (1891)
Rust (*Uromyces caryophyllinus*, (Schrank) Schrt.)
Descr. Illus., Gar. and For., Vol. V, pp. 18 & 19. (1892)
Treat. (pos.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 96, pp. 334 & 335. (1895)
N. Y. Agr. Exp. Sta., Bull. 100, pp. 50–68. (1896)
Gar. & For., Vol. X, p. 444. (1897)
Wilt (*Fusarium* sp ?)
Descr., Conn. Agr. Exp. Sta., Rep. 21, 1897, pp. 175–181. (1898)

Carrot.

(*Daucus Caroa*, L.)

Rot (*Phoma sanguinolenta*, Grove) (21)

Catalpa.

(*Catalpa Bignonioides*, Walt.)

Leaf-Blight (*Macrosporium Catalpæ*, Ell. & Mart.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 364 & 365. (1888)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 366. (1888)
Leaf-Spot (*Phyllosticta Catalpæ*, Ell. & Mart.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 364 & 365. (1888)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 366. (1888)

Celery.

(*Apium graveolens*, L.)

Blight or Rot (Bacterial). (22)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 257 & 258. (1892)
Leaf-blight (*Cercospora Apii*, Fres.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1886, pp. 117–120. (23) (1887)
Treat. (pos.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 251. (1892)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 132, pp. 203–205. (1897)
R. I. Agr. Exp. Sta., Bull. 44, pp. 22–25. (1897)
Conn. Agr. Exp. Sta., Rep. 21, 1897, pp. 167–171. (1898)
Leaf-Spot (*Phyllosticta Apii*, Halsted.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 253. (1892)
Leaf-Spot (*Septoria Pretoselini*, Desm., *var. Apii*, Br. & Cav.)
Descr. Illus., N. Y. Agr. Exp. Sta., Bull. 51, pp. 137 & 138. (1893)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 132, pp. 206–215. (1897)
Treat. (rec.), N. Y. Agr. Exp. Sta., Bull. 51, pp. 139–141. (1893)
Rust (*Puccinia bullata*, (Pers.) Schrt.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 256 & 257. (1892)

Cherry.

(*Prunus Cerasus*, L.)

Black Knot (*Plowrightia morbosa*, (Schw.) Sacc.) (24)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 8, 1890, pp. 200–210. (1891)
N. J. Agr. Exp. Sta., Bull. 78, pp. 2–10. (1891)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 81, pp. 638–646. (1894)
Cf. N. Y. Agr. Exp. Sta., Rep. 12, 1893, pp. 686–688. (1894)
Treat. (pos.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 81, pp. 646–653. (1894)

Fruit-Mold (*Oidium fructigenum*, Kze. & Schm.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 349–352. (1889)
Ky. Agr. Exp. Sta., Rep. 2, 1889, pp. 31–34. (1890)
Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 213. (1891)
Treat. (pos.), Ky. Agr. Exp. Sta., Rep. 2, 1889, pp. 35–42. (1890)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 98, p. 409. (1895)

Leaf-Curl (*Exoascus Cerasi*, (Fckl.) Sadeb.)
Descr., N. Y. Agr. Exp. Sta., Rep. 14, 1895, pp. 532 & 533. (1896)

Leaf-Spot (*Cylindrosporium Padi*, Karst., = *Septoria cerasina*, Pk.)
Descr. Illus., Scribner, Fung. Dis., p. 119. (1890)
Iowa Agr. Exp. Sta., Bull. 13, pp. 61–65. (1891)
Treat. (pos.), U. S. Dep. Agr., Rep. for 1890, pp. 396 & 397. (1891)
N. Y. Agr. Exp. Sta., Rep. 11, 1892, pp. 654–659. (1893)
Iowa Agr. Exp. Sta., Bull. 30, pp. 291–294. (1895)
Cf. Plum (Leaf-Spot).

Powdery Mildew (*Podosphaera oxyacanthae*, (DC.) DBy.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 352–356. (1889)
Treat. (pos.), Iowa Agr. Exp. Sta., Bull. 17, pp. 421–433. (1892)
Cf Apple (Powdery Mildew).

Rust (*Puccinia Pruni*, Pers.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 353 & 354. (1888)
Cf. Plum (Rust).

Scab (*Cladosporium carpophilum*, Thüm.)
See Plum and Peach (Scab).

Chestnut.

(*Castanea sativa*, Mill.)

Anthracnose (*Marsonia ochroleuca*, B. & C.)
Occ. Illus., N. J. Agr. Exp. Sta., Rep. 17, 1896, p. 412. (1897)

Anthracnose (*Cylindrosporium castanicolum*, (Desm.) Berl.) (25)

Chrysanthemum.

(*Chrysanthemum Sinense*, Sabine.)

Anthracnose (*Cylindrosporium Chrysanthemi*, Ell. & Dearn.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 15, 1894, pp. 365–368. (1895)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 15, 1894, p. 369. (1895)

Leaf-Spot (*Phyllosticta Chrysanthemi*, Ell. & Dearn.)
Occ., N. J. Agr. Exp. Sta., Rep. 15, 1894, p. 368. (1895)
Leaf-Spot (*Septoria Chrysanthemi*, Cav.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 15, 1894, pp. 363–365. (1895)
Treat. (pos.), N. Y. Agr. Exp. Sta., Rep. 11, 1892, pp. 557–560. (1893)

Clematis.

(*Clematis* spp.)

Root-Rot (*Phoma* sp.)? (26)
Descr., N. Y. Agr. Exp. Sta., Rep. 3, 1884, pp. 383 & 384. (1885)

Clover.

(*Trifolium*, spp.)

Rust (*Uromyces Trifolii*, (A. &. S.) Wint.)
Descr. Illus., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 24. (1890)
Iowa Agr. Exp. Sta., Bull. 13, pp. 51–55. (1891)
Treat. (rec.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 24, p. 139. (1890)
Stem-Rot (*Sclerotinia Trifolium*, Erick.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 3, 1890, pp. 84–88. (1891)
Treat. (rec.), Del. Agr. Exp. Sta., Rep. 6, 1893, p. 110. (1894)

Corn.

(*Zea Mays*, L.)

Blight (Bacterial).
Descr. Illus., Ill. Agr. Exp. Sta., Bull. 6. (1889)
Treat. (neg.), Ill. Agr. Exp. Sta., Bull. 6, p. 174. (1889)
Leaf-Blight (*Helminthosporium graminum*, Rab.)
Occ., Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 171. (1890)
Rust (*Puccinia Maydis*, Bérang.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, p. 390. (1888)
Treat. (neg.), U. S. Dep. Agr., Rep. for 1887, p. 391. (1888)
Smut (*Ustilago Mays Zeae* (DC) Magn.) and (*U. Reiliana*, Kühn.)
Descr. Illus., U. S. Dep. for 1887, pp. 380–386. (1888)
Kans. Agr. Exp. Sta., Bull. 62, pp. 179–189 & 198–201. (1896)
Treat. (rec.), Neb. Agr. Exp. Sta., Bull. 11, pp. 31–34. (1889)
Ohio Agr. Exp. Sta., Bull. 78, pp. 94 & 95. (1897)

Cosmos.

(*Cosmos bipinnatus*, Cav.)

Stem-Spot (*Phylctaena*, sp.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 15, 1894, pp. 371 & 372. (1895)
Treat. (neg.), N. J. Agr. Exp. Sta., Rep. 17, 1896, p. 400. (1897)

Cotton.

(*Gossypium*) spp.)

Anthracnose (*Colletotrichum Gossypii*, Southworth.)
Descr. Illus., Jour. Mycol., Vol. VI, pp. 100–104 & 173–177. (1891)
Ala. Agr. Exp. Sta., Bull. 41, pp. 40–49. (1892)
"Black Rust" (*Bacteria and Various Fungi.*)
Descr. Illus., Ala. Agr. Exp. Sta., Bull. 27. (1891)
Boll-Rot (*Bacillus gossypina*, Stedm.)
Descr. Illus., Ala. Agr. Exp. Sta., Bull. 55. (1894)
Treat. (rec.), Ala. Agr. Exp. Sta., Bull. 55, p. 11. (1894)
"Damping-off" (*Fungus indet.*)
Descr., Ala. Agr. Exp. Sta., Bull. 41, pp. 30–39. (1892)
"Frenching" (*Fusarium vasinfectum*, Atkinson.)
Descr. Illus., Ala. Agr. Exp. Sta., Bull. 41, pp. 19–29. (1892)
Leaf-Blight (*Cercospora gossypina*, Cke.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 355 & 356. (1888)
Ala. Agr. Exp. Sta., Bull. 41, pp. 58–61. (1892)
Leaf-Mould *Ramularia areola*, Atkinson.)
Descr. Illus., Ala. Agr. Exp. Sta., Bull. 41, pp. 55–58. (1892)
Leaf-Spot (*Sphaerella gossypina*, Atkinson.)
Descr. Illus., Ala. Agr. Exp. Sta., Bull. 41 pp. 58–60. (1892)
Root-Rot (*Ozonium auricomum*, Lk.)
Descr. Illus., Tex. Agr. Exp. Sta., Rep. 2, 1889, pp. 67–76. (1890)
Treat. (rec), Tex. Agr. Exp. Sta., Rep. 2, 1889, p. 85. (1890)

Cranberry.

(*Vaccinium Oxycoccus*, L.)

Gall (*Synchytrium Vaccinii*, Thomas.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 64, pp. 4–9. (1889)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 64, p. 16. (1889)
N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 333. (1891)
"Scald" (*Fungus indet.*)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 64, pp. 30–34. (1889)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 64, pp. 39 & 40. (1889)
Journ. Mycol., Vol. VI, p. 18. (1890)

Cucumber.

(*Cucumis sativus*, L.)

Anthracnose (*Colletotrichum Lagenarium*, (Pass.) Ell. & Hals.)
Descr., Mass. (Hatch) Agr. Exp. Sta., Rep. 9, 1896, p. 71. (1897)
Treat. (pos.), N. J. Agr. Exp. Sta., Rep. 17, 1896, pp. 340–343. (1897)
Occ., Cf. Melon (Anthracnose.)

Blight (Bacterial.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 273–276. (27) (1892)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 276. (1892)
Cf. Cucumber (Wilt.)
"Damping-off" or Seedling-Mildew (*Pythium De Baryanum*, Hesse.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 220. (1891)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 221. (1891)
Downy Mildew (*Plasmopara Cubensis*, (B. & C.) Humphrey.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 8, 1890, pp. 210–212. (1891)
N. Y. Agr. Exp. Sta., Bull. 119, pp. 158–165. (1897)
Treat. (pos.), N. Y. Agr. Exp. Sta., Bull. 119, pp. 170–174. (1897)
Leaf-Glaze (*Acremonium* sp.)
Descr., Mass. Agr. Exp. Sta., Rep. 9, 1891, p. 227. (1892)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 230. (1893)
Leaf-Spot (*Phyllosticta* sp.)
Occ., Ohio Agr. Exp. Sta., Bull. 73, p. 235. (1896)
Powdery Mildew (*Erysiphe cichoracearum*, DC.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 225. (1893)
Treat. (pos.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull 31, p. 138. (1891)
Mass. Agr. Exp. Sta., Rep. 9, 1891, p. 225. (1892)
Scab (*Cladosporium cucumerinum*, Ell. & Arth.) (28)
Descr. Illus., Ind. Agr. Exp. Sta., Bull. 19, pp. 8–10. (1889)
Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 227–229. (1893)
Stem-Rot (*Sclerotinia Libertiana*, Fckl.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 212–224. (1893)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 222. (1893)
Wilt (*Bacillus tracheiphilus*, Smith.) (29)

Currant.

(*Ribes*, spp.)

Anthracnose (*Glœosporium Ribis*, (Lib.) Mont. & Desm.)
Descr. Illus., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 15, p. 196. (1889)
Knot (*Nectria cinnabarina*, (Tode) Fr. and *Pleonectria Berolinensis*, Sacc.)
Descr. Illus., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 125. (1897)
Treat. (rec.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 125, p. 38. (1897)
Leaf-Spot (*Septoria Ribis*, Desm., and *Cercospora angulata*, Wint.)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 13, pp. 68 & 69. (1891)
Treat. (pos.), Iowa Agr. Exp. Sta., Bull. 30, pp. 289–291. (1895)
Powdery Mildew (*Sphaerotheca mors-uvae* (Schw.) B. & C.)
See Gooseberry (Powdery Mildew.)

Egg-plant.

(*Solanum Melongena*, L.)

Anthracnose (*Glœosporium melongenae*, Ell. & Hals.)
Occ., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 281. (1892)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 330–333.
Blight (*Bacillus Solanacearum*, Smith.)
Descr. Illus., U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 12. (1896)
Treat. (rec.), U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 12, pp. 23 & 24. (1896)
"Damping-off," or Seedling-Mildew (*Pythium DeBaryanum*, Hesse.)
Descr., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 286. (1893)
Cf. Cucumber (Damping-off.)
Fruit-Mold (*Botrytis fascicularis*, (Cord.) Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 357. (1891)
Leaf-Spot (*Phyllosticta hortorum*, Speg.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 11, 1890, pp. 355–357. (1891)
Treat. (pos.), N. J. Agr. Exp. Sta., Rep. 17, 1896, pp. 337–340. (1897)
Rot (*Penicillium* sp.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 14, 1893, pp. 362–366 (1894)
Seedling-Rot (*Phoma Solani*, Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 277–279. (1892)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 279. (1892)
Stem-Rot (*Nectria Ipomoeae*, Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 281–283. (1892)

Fig.

(*Ficus Carica*, L.)

Leaf-Blight (*Cercospora Bolleana*, (Thm.) Sacc.) (30)
Occ., U. S. Dep. Agr., Div. Pomol., Bull. 5, pp. 27 & 28. (1897)
Rust (*Uredo Fici*, Cast.)
Occ., N. C. Agr. Exp. Sta., Bull. 92, p. 117. (1893)
Scab (*Fusarium roseum*, Lk.)
Occ., N. C. Agr. Exp. Sta., Bull. 92, p. 117. (1893)

Filbert.

(*Corylus Avellana*, L. and *C. Americana*, Walt.)

Black Knot (*Cryptosporella anomala*, (Pk.) Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 287–289. (1893)
Cf. Hazel (Black Knot.)

Flax.

(*Linum* spp.)

Rust (*Melampsora Lini*, (DC.) Tul.) (31)
Occ., Journ. Mycol., Vol. V, p. 215. (1889)

Geranium.

(*Pelargonium spp.*)

Rot (*Bacillus* sp.)
Descr. Illus., Journ. Mycol., Vol. VI, pp. 114 & 115. (1891)

Gooseberry.

(*Ribes Grossularia*, L.)

Leaf-Spot (*Septoria Ribis*, Desm., and *Cercospora angulata*, Wint.)
Cf. Currant (Leaf-Spot.)
Leaf-Spot (? *Sphaerella Grossulariae*, (Fr.) Awd.)
Occ. Illus., Iowa Agr. Exp. Sta., Bull. 18, p. 70. (1891)
Powdery Mildew (*Sphaerotheca mors-uvae*, (Schw.) B. & C.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 373–378. (1888)
Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 240. (1893)
Treat. (pos.), N. Y. Agr. Exp. Sta., Bull. 36, p. 645. (1891)
N. C. Agr. Exp. Sta., Bull. 92, p. 131. (1893)
Rust (*Aecidium Grossulariae*, Schum.)
Descr., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 241. (1893)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 241. (1893)

Grape.

(*Vitis spp.*)

Anthracnose or Bird's-Eye Rot (*Sphaceloma ampelinum*, DBy.)
Descr. Illus., Tenn. Agr. Exp. Sta., Bull. IV–4, pp. 111 & 112. (1891)
Descr., U. S. Dep. Agr., Div. Veg. Path., Bull. 2, pp. 170–172. (1892)
Treat. (rec.), N. Y. Agr. Exp. Sta., Rep. 9, 1890, pp. 336 & 337. (1891)
Conn. Agr. Exp. Sta., Rep. 14, 1890, p. 102. (1891)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 76, p. 443 (1894)
Bacteriosis (*Bacillus* sp.) (32) (33)
See U. S. Dep. Agr., Exp. Sta. Rec., VI, pp. 231 & 232.
Bitter-Rot (*Melanconium fuligineum*, (Scrib. & Viala.) Cav.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 324 & 325. (1888)
Scribner, Fung. Dis., pp.37–40. (1890)
Treat. (rec.), Scribner, Fung. Dis., p. 40. (1890)
Cf. N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 61, pp. 302–305.
Black-Rot (*Laestadia Bidwellii*, (Ell.) Viala & Ravaz.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1886, pp. 109–111. (1887)
Del. Agr. Exp. Sta., Bull. 6, pp. 18–27. (1889)
Tenn. Agr. Exp. Sta., Bull. IV–4, pp. 97–102. (1891)
Tex. Agr. Exp. Sta., Bull. 23, pp. 219–228. (1892)
Treat. (pos.), Conn. Agr. Exp. Sta., Rep. 14, 1890, pp. 100 & 101. (1891)
U. S. Dep. Agr., Farm Bull. 4, pp. 8 & 9. (1891)
Del. Agr. Exp. Sta., Bull. 15, pp. 3–7. (1892)
Tex. Agr. Exp. Sta., Bull. 23, pp. 228–231. (1892)

Brunissure
(*Plasmodiophora Vitis*, Viala & Sauv. and *P. Californica*, V. & S. (34)
(*Pseudocommis Vitis*, Debray.) (35)
Cf. U. S. Dep. Agr., Exp. Sta. Rec., VII-3, pp. 221 & 222. (1895)
(*Cladochytrium viticolum*, Prunet.) (36)

Chytridiose (*Cladochytrium viticolum*, Prunet.) (37)
See U. S. Dep. Agr., Exp. Sta. Rec., VI-7, pp. 642-644. (1895)

Downy Mildew (*Plasmopara viticola*, (B. & C.) Berl. & De Ton.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1886, pp. 96-99. (1887)
Tenn. Agr. Exp. Sta., Bull. IV-4, p. 108. (1891)
Mich. Agr. Exp. Sta., Bull. 83, pp. 9-12. (1892)
Treat. (pos.), Ohio Agr. Exp. Sta., Bull. III-10, p. 268. (1890)
U. S. Dep. Agr., Farm. Bull. 4, p. 8. (1891)
Tenn. Agr. Exp. Sta., Bull. IV-4, p. 110. (1891)

Fruit-Rot (*Botrytis* sp.) (38)

Leaf-Blight (*Cercospora viticola*, (Ces.) Sacc.)
Descr. Illus., Scribner, Fung. Dis., pp. 60-62. (1890)
Descr., N. Y. Agr. Exp. Sta., Rep. 9, 1890, p. 324. (1891)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 122. (1893)

Leaf-Mold (*Septosporium heterosporum*, Ell. & Gall.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 381-383. (1889)

Leaf-Spot (*Sphaerella* sp.) (39)

Mold (*Botrytis cinerea*, Pers.) (40)

Powdery Mildew (*Uncinula spiralis*, B. & C.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1886, pp. 105-108. (1887)
Descr., N. Y. Agr. Exp. Sta., Rep. 9, 1890, pp. 322-323. (1891)
U. S. Dep. Agr., Div. Veg. Path., Bull. 2, pp. 166-170. (1892)
Treat. (pos.), U. S. Dep. Agr., Farm. Bull. 4, p. 8. (1891)
Ind. Agr. Sta., Bull. 38, p. 17. (1892)
N. C. Agr. Exp. Sta., Bull. 92, pp. 120 & 121. (1893)

Ripe-Rot or Anthracnose (*Glœosporium fructigenum*, Berk.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1890, p. 408. (1891)
Journ. Mycol., Vol. VI, pp. 164-171. (1891)
Cf. Apple (Anthracnose.)

Root-Rot (*Armillaria mellea*, (Wallr.) Fr. and *Dematophora necatrix*, Hartig.) (41)
Descr. Illus., Scribner, Fung. Dis., pp. 64-69. (1890)
Descr., U. S. Dep. Agr., Div. Veg. Path., Bull. 2, pp. 153-159. (1892)
Treat. (rec.), Scribner, Fung. Dis., pp. 70 & 71. (1890)
N. C. Agr. Exp. Sta., Bull. 92, p. 122. (1893)

Scab (*Cladosporium viticolum*, Ces.)
Descr., U. S. Dep. Agr., Div. Veg. Path., Bull. 2, pp. 173 & 174. (1892)

Scald (*Aureobasidium Vitis*, Viala & Boyer.) (42)
See U. S. Dep. Agr., Exp. Sta. Rec., VI-3, pp. 230 & 231. (1894)

White-Rot (*Coniothyrium Diplodiella*, (Speg.) Sacc.) (43)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 325 & 326. (1888)
Scribner, Fung. Dis., pp. 41-44. (1890)
Treat. (pos.), U. S. Dep. Agr., Sec. Veg. Path., Bull. 11, p. 69. (1890)

Hazel.

(*Corylus*, spp.)

Black-Knot (*Cryptosporella anomala*, (Pk.) Sacc.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 242. (1893)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 243. (1893)
Cf. Filbert (Black Knot).

Hollyhock.

(*Althaea rosea*, Cav.)

Anthracnose (*Colletotrichum Malvarum*, (Braun. & Casp.) Southworth.)
Descr. Illus., Journ. Mycol., Vol. VI, pp. 46–48. (1890)
Treat. (pos.), Journ. Mycol., Vol. VI, p. 50. (1890)
N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 362. (1891)
Leaf-Blight (*Cercospora althaeina*, Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 361. (1891)
Treat. (pos.), N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 361. (1891)
Leaf-Spot (*Phyllosticta althaeina*, Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 297. (1892)
Rust (*Puccinia Malvacearum*, Mont.) (44)
Descr. Illus., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 25, p. 154. (1890)
Treat. (rec.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 25, p. 155. (1890)

Horse-Chestnut.

(*Æsculus Hippocastanum*, L.)

Leaf-Spot (*Phyllosticta sphaeropsoidea*, Ell. & Ev.)
Tr. (pos.), Journ. Mycol., Vol. VII, p. 353. (1894)

Horseradish.

(*Cochlearia Armoracia*, L.)

Leaf-Blight (*Ramularia Armoraciae*, Fckl.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 360. (1891)
Leaf-Spot (*Septoria Armoraciae*, Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 360. (1891)

Hyacinth.

(*Hyacinthus orientalis*, L.)

Bacteriosis (*Bacillus Hyacinthi septicus*, Heinz.) (45)
Yellow Disease (*Bacillus Hyacinthi*, (Wakk.) Trev.) (46)

Hydrangea.

(*Hydrangea Hortensia*, Siebold.)

Leaf-Spot (*Phyllosticta Hydrangeae*, Ell. & Ev.)
Occ., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 298. (1892)

Larch.

(*Larix Europaea*, DC.)

Blister (*Peziza Willkommii*, Hartig.) (47)

Lemon.

(*Citrus Medica*, var. *Limon*, L.)

Foot-Rot (*?Fusisporium Limoni*, Briosi).
    See Orange, (Foot-Rot).
Fruit-Spot (*Trichoseptoria Alpei*, Cav.) (48)
Melanose (*?Fungus indet.*)
    See Orange (Melanose).
Scab (*Cladosporium* sp.)
    Descr. Illus., U. S. Dept. Agr., Div. Veg. Phys. & Path., Bull. 8, pp. 20-23. (1896)
    Treat. (pos.), U. S. Dept. Agr., Div. Veg. Phys. & Path., Bull. 8, pp. 23 & 24. (1896)
Sooty Mold (*Meliola Penzigi*, Sacc. and *M. Camelliae*, (Catt.) Sacc.)
    See Orange, (Sooty Mold).

Lettuce.

(*Lactuca sativa*, L.)

Anthracnose (*Marsonia perforans*, Ell. & Ev.)
    Descr. Illus., Ohio Agr. Exp. Sta., Bull. 73, pp. 222 & 223. (1897)
    Treat. (rec.), Ohio Agr. Exp. Sta., Bull. 73, pp. 225 & 226. (1897)
Downy Mildew (*Bremia Lactucae*, Regel.)
    Descr. Illus., N. Y. Agr. Exp. Sta., Rep. 4, 1885, p. 253. (1886)
    Treat. (pos.), Mass. (Hatch) Agr. Exp. Sta., Bull. 4, pp. 11-14. (1889)
        Ohio Agr. Exp. Sta., Bull. 73, p. 226. (1897)
Leaf-Rot (*Botrytis vulgaris*, Fr.) (49)
    Descr., Mass. Agr. Exp. Sta., Rep. 9, 1891, pp. 219-221. (1892)
    Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 9, 1891, p. 221. (1892)
        Ohio Agr. Exp. Sta., Bull. 73, pp. 221 & 222. (1897)
Leaf-Spot (*Septoria consimilis*, Ell. & Mart.)
    Descr. Illus., Ohio Agr. Exp. Sta., Bull. 44, pp. 145 & 146. (1892)
Stem-Rot (Bacterial.)
    Descr., Vt. Agr. Exp. Sta., Rep. 6, 1892, p. 87. (1893)
    Treat. (rec.), Vt. Agr. Exp. Sta., Rep. 6, 1892, p. 88. (1893)

Lily.

(*Lilium* spp.)

Bermuda Disease. (50)
Bulb-Rot (*Rhizopus necans*, Massee). (51)
    See Gar. & For., X-504, p. 414. (1897)
Mold or Ward's Disease (*Botrytis* sp.) (52)
    Treat. (pos.) Gar. & For., IX-414, p. 44. (1896)
    See N. J. Agr. Exp. Sta., Rep. 14, 1893, pp. 392-394.

Maple.

(*Acer*, spp.)

Anthracnose (*Glœosporium apocryptum*, Ell. & Ev.)
Descr., N. Y. Agr. Exp. Sta., Rep. 14, 1895, pp. 531 & 532. (1896)
Treat. (rec.), N. Y. Agr. Exp. Sta., Rep. 14, 1895, p. 532. (1896)
Leaf-Spot (*Phyllosticta acericola*, Cke. & Ell.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 383–386. (1889)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1888, p. 386. (1889)

Melon.

(*Cucumis Melo*, L.)

Anthracnose (*Colletotrichum lagenarium*, (Pass.) Ell. & Hals.)
Descr., U. S. Dep. Agr., Bot. Div., Bull. 8, p. 64. (1889)
Descr. Illus., Okla. Agr. Exp. Sta., Bull. 15, pp. 30 & 31. (1895)
Treat. (pos.), Md. Agr. Exp. Sta., Rep. 4, 1891, p. 387. (1892)
(neg.) Okla. Agr. Exp. Sta., Bull. 15, pp. 31 & 32. (1895)
Anthracnose (*Colletotrichum oligochaetum*, Cav.) (53)
Blight (Bacterial.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 273–276. (1892)
Cf. Melon, (Wilt.)
Downy Mildew (*Plasmopara Cubensis*, (B. & C.) Humphrey.)
See Cucumber (Downy Mildew.)
Leaf-Blight (*Cercospora Melonis*, Cke.) (54)
Leaf-Mold (*Alternaria Brassicae*, Sacc., var. *nigrescens*, Pegl.) (55)
Descr., Conn. Agr. Exp. Sta., Rep. 19, 1895, pp. 186 & 187. (1896)
Descr. Illus., Ohio Agr. Exp. Sta., Bull. 73, pp. 235 & 236. (1897)
Leaf-Spot (*Phyllosticta* sp.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 14, 1893, p. 355. (1894)
Scab (*Scolecotrichum melophthorum*, Pr. & Del.) (56)
Wilt (*Bacillus tracheiphilus*, Smith.)
See Cucumber, (Wilt.)

Mignonette.

(*Reseda odorata*, L.)

Leaf-Blight (*Cercospora Resedae*, Fckl.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1889, pp. 429 & 430. (1890)
Treat. (pos.), U. S. Dep. Agr., Rep. for 1889, p. 431. (1890)

Mulberry. (57)

(*Morus*, spp.)

Bacteriosis (Bacterial.) (58)
Chytridiose (*Cladochytrium Mori*, Prunet.)
See U. S. Dept. Agr., Exp. Sta. Rec., VI-9, p. 830. (1895)

Nasturtium.

(*Tropaeolum Majus*, L.)

Leaf-Blight (*Alternaria*, sp., and *Pleospora Tropaeoli*, Hals.)
Descr., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 290–298. (1893)

Oats.

(*Avena sativa*, L.)

Blight (Bacterial.)
Descr., Journ. Mycol., Vol. VI, p. 72. (1890)
Leaf-Spot (*Phyllosticta* sp.)
Descr., N. J. Agr. Exp. Sta., Rep. 15, 1894, p. 319. (1895)
Mold (*Helminthosporium inconspicuum*, Cke. & Ell., var *brittanicum* Gr. and *Cladosporium herbarum*, (Pers.) Lk.)
Descr. Me. Agr. Exp. Sta., Rep. for 1894, pp. 95 & 96. (1895)
Rust (*Puccinia coronata*, Cda., *P. graminis*, P., and *P. Rubigo-vera*, (DC) Wint.)
Descr. Illus., Kan. Agr. Exp. Sta., Bull. 38. (1893)
Cf. Wheat (Rust.)
Smut (*Ustilago Avenae*, (P.) Jensen and *U. Avenae* var. *levis*, Kell. & Sw.)
Descr. Illus., Kan. Agr. Exp. Sta., Rep. 2, 1889, pp. 215–238, 259 & 260. (1890)
R. I. Agr. Exp. Sta., Bull. 15, pp. 5 & 6. (1892)
U. S. Dept. Agr., Year-book for 1894, pp. 412–414. (1895)
Ohio Agr. Exp. Sta., Bull. 64, pp. 123–126. (1896)
Treat. (pos.), U. S. Dept. Agr., Year-book for 1894, pp. 415–419. (1895)
Ohio Agr. Exp. Sta., Bull. 64, pp. 130–133. (1896)
Wis. Agr. Exp. Sta., Bull. 50, pp. 6–13. (1896)

Okra.

(*Hibiscus esculentus*, L.)

"Frenching" (*Fusarium vasinfectum*, Atk.)
Occ., Ala. Agr. Exp. Sta., Bull. 41, p. 25. (1892)
Cf. Cotton ("Frenching").

Olive.

(*Olea Europaea*, L.)

Scab (*Cycloconium oleaginum*, Cast.)
Descr., Cal. Agr. Exp. Sta., Rep. 1892–93, pp. 297 & 298. (1894)
Tuberculosis (Bacterial.)
Descr. Illus., Journ. Mycol., Vol. VI, pp. 148–153. (1891)

Onion.

(*Allium Cepa*, L.)

- Anthracnose or Rot (*Vermicularia circinans*, Berk.)
  - Descr. Illus., Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 163. (1890)
  - Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 164 & 165. (1890)
- Downey Mildew (*Peronospora Schleideniana*, DBy.)
  - Descr. Illus., Wis. Agr. Exp. Sta., Rep. 1, 1883, pp. 38–44. (1884)
  - Descr., Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 155 & 156. (1890)
  - Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 157. (1890)
    - Vt. Agr. Exp. Sta., Rep. 10, 1896–97, pp. 61 & 62. (1897)
- Mold (*Macrosporium Sarcinula*, B. var. *parasiticum*, Thm., and *M. Porri*, Ell.)
  - Descr. Illus., Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 158–162. (1890)
  - Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 161. (1890)
- Smut (*Urocystis Cepulae*, Frost)
  - Descr. Illus., Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 129–146. (1890)
  - Treat. (pos.), Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 147–153. (1890)
    - (Transplanting), Conn. Agr. Exp. Sta., Rep. 19, 1895, pp. 176–182. (1896)
  - Cf. Ohio Agr. Exp. Sta., Bull. III–9, pp. 244–249.
    - N. Dak. Agr. Exp. Sta., Bull. 12. (1894)
    - U. S. Dept. Agr., Farm. Bull. 39, pp. 16–20. (1896)

Orange.

(*Citrus Aurantium*, L. and *C. nobilis*, Lour.)

- Anthracnose (*Colletotrichum adustum*, Ell.)
  - Occ., Journ. Mycol., Vol. VII, pp. 34 & 35. (1891)
- Foot Rot or Mal-di-gomma (*Fusisporium Limoni*, Briosi.)
  - Descr. Illus. Treat. (rec.), U. S. Dept. Agr., Div. Veg. Phys. & Path., Bull. 8, pp. 28–31. (1896)
- Leaf-glaze (*Strigula complanata*, Fée.)
  - Occ., Journ. Mycol., Vol. VII, p. 36. (1891)
- Melanose (*Fungus indet.*) (59)
  - Descr. Illus. Treat. (pos.), U. S. Dept. Agr., Div. Veg. Phys. & Path., Bull. 8, pp. 33–38. (1896)
- Scab (*Cladosporium* sp.)
  - See Lemon (Scab.)
- Sooty Mold (*Meliola Penzigi*, Sacc. and *M. Camelliae*, (Catt.) Sacc.)
  - Descr. Illus. Treat. (pos.), U. S. Dept. Agr., Div. Veg. Phys. & Path., Bull. 13. (1897)

Orchid. (60)

(*Orchidaceae.*)

- Anthracnose (*Glœosporium cinctum* B. & C. and *Colletotrichum Bletiae*, Hals.)
  - Descr., N. J. Agr. Exp. Sta., Rep. 14, 1893, pp. 414–417. (1894)
- Anthracnose (*Glœosporium macropus*, Sacc.) (61)
- Leaf-Blight (*Cercospora Angreci*, Roum.) (62)

Parsnip.

(*Pastinaca sativa*, L.)

Leaf-Blight (*Cercospora Apii*, Fres.)
Occ., N. J. Agr. Exp. Sta., Rep. 15, 1894, p. 351. (1895)
Cf. Celery (Leaf-Blight).

Pea.

(*Pisum sativum*, L.)

Leaf-Spot (*Ascochyta Pisei*, Lib.) (63)
Descr., N. J. Agr. Exp. Sta., Rep. 14, 1893, p. 358. (1894)
Leaf-Spot (*Septoria Pisi*, West.)
Occ., N. J. Agr. Exp. Sta., Rep. 14, 1893, p. 358. (1894)
Mold (*Pleospora Pisi*, (Sow.) Fckl.)
Occ., N. J. Agr. Exp. Sta., Rep. 14, 1893, p. 358. (1894)
Powdery Mildew (*Erysiphe Martii*, Lév.)
Descr., N. J. Agr. Exp. Sta., Rep. 14, 1893, p. 357. (1894)
Cf. Bean (Powdery Mildew.)

Peach.

(*Prunus Persica*, Benth. & Hook.)

Anthracnose (*Glœosporium laeticolor*, Berk.)
Occ., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 325. (1893)
Fruit-Mold or Twig-Blight (*Oidium fructigenum*, Kze. & Schm.)
Descr. Illus., Journ. Mycol., Vol. VII, pp. 36–38. (1891)
Treat. (pos.), Del. Agr. Exp. Sta., Rep. 8, 1895–96, pp. 50 & 51. (1896)
Del. Agr. Exp. Sta., Bull. 34, pp. 12 & 13. (1897)
Cf. Cherry (Fruit-Mold.)
Fruit-Spot (*Helminthosporium carpophilum*, Lév.)
Occ., Mich. Agr. Exp. Sta., Bull. 103, p. 57. (1894)
Leaf-Blight or Shot-hole (*Cercospora Persica*, Sacc.)
Occ., N. C. Agr. Exp. Sta., Bull. 92, p. 103. (1873)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 103. (1893)
Leaf-Blight or Frosty Mildew (*Cercosporella Persica*, Sacc.)
Occ., Journ. Mycol., Vol. VII, p. 91. (1892)
Leaf-Curl (*Exoascus deformans*, (Berk.) Fckl.)
Descr. Illus., Scribner, Fung. Dis., pp. 127–130. (1890)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 73, pp. 324 & 325. (1894)
Treat. (pos.), Mich. Agr. Exp. Sta., Bull. 103, pp. 56 & 57. (1894)
Powdery Mildew (*Sphaerotheca pannosa*, (Wallr.) Lév. and *Podosphaera oxyacanthae*, (DC.) DBy.
Occ., Journ. Mycol., Vol. VII, p. 90. (1892)
Descr. Illus. N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 74, p. 381. (1894)
Rust (*Puccinia Pruni*, P.) (64)
See Cherry (Rust).

Scab (*Cladosporium carpophilum*, Thüm.)
Descr. Illus., Ind. Agr. Exp. Sta., Bull. 19, pp. 5–8. (1889)
Del. Agr. Exp. Sta., Rep. 8, 1895–96, pp. 60–63. (1896)
Treat. (pos.), Del. Agr. Exp. Sta., Rep. 8, 1895–96, p. 63. (1896)
Cf. N. J. Agr. Exp. Sta., Rep. 15, 1894, pp. 328–330. (On leaves.)
Conn. Agr. Exp. Sta., Rep. 20, 1896, pp. 269–271. (On twigs.)

Pear.

(*Pirus Communis*, L.)

Anthracnose (*Colletotrichum*, sp.)
Occ., N. J. Agr. Exp. Sta., Rep. 15, 1894, p. 331. (1896)
Dry-Rot (*Thelephora pedicellata*, Schw.)
Descr., Journ. Mycol., Vol. VI, pp. 113 & 114. (1891)
Treat. (pos.), Journ. Mycol., Vol. VI, p. 114. (1891)
Fire-Blight (*Micrococcus amylovorus*, Burrill.)
Descr. Illus., N. Y. Agr. Exp. Sta., Rep. 5, 1886, pp. 275–289. (1887)
Descr., Conn. Agr. Exp. Sta., Rep. 18, 1894, pp. 113–116. (1895)
U. S. Dept. Agr., Year-book for 1895, pp. 295–298. (1896)
Treat. (pos.), Conn. Agr. Exp. Sta., Rep. 18, 1894, p. 116. (1895)
U. S. Dept. Agr., Year-book for 1895, pp. 298–300. (1896)
Cf. Apple (Fire-Blight.)
Leaf-Spot (*Entomosporium maculatum*, Lév.).
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 357–362. (1889)
Del. Agr. Exp. Sta., Bull. 13, pp. 4–6. (1891)
Del. Agr. Exp. Sta., Bull. 15, pp. 7 & 10. (1892)
U. S. Dep. Agr., Farm. Bull. 7, p. 15. (1892)
Cf. Quince (Leaf-Spot.)
Rust (*Gymnosporangium globosum*, Farl.)
Occ., Conn. Agr. Exp. Sta., Rep. 14, 1890, p. 98. (1891)
Scab (*Fusicladium pirinum*, (Lib.) Fckl.) (65)
Descr. Illus., N. Y. Agr. Exp. Sta., Bull. 67, pp. 191 & 192. (1894)
Treat. (pos.), U. S. Dep. Agr., Farm. Bull. 7, p. 15. (1892)
Vt. Agr. Exp. Sta., Bull. 44, pp. 85–90. (1895)
N. Y. Agr. Exp. Sta., Bull. 84, pp. 3–18. (1895)
Cf. Apple (Scab).

Peppers.

(*Capsicum annuum*, L.)

Anthracnose (*Colletotrichum nigrum*, Ell. & Hals. and *Glœosporium piperatum*, Ell. & Ev.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 11, 1890, pp. 358 & 359. (1891)
Treat. (neg.), N. J. Agr. Exp. Sta., Rep. 17, 1896, p. 337. (1897)
Cf. N. J. Agr. Exp. Sta., Rep. 13, pp. 332 & 333. (1893)
Mold (*Macrosporium* sp.)
Occ., N. J. Agr. Exp. Sta., Rep. 15, 1894, p. 351. (1895)

Persimmon.

(*Diospyros*, spp.)

Miscellaneous Fungous Diseases. { *Agaricus.* *Cercospora.* *Glœosporium.*
See N. C. Agr. Exp. Sta., Bull. 92, p. 116. (1893)

Pink (Sweet William).

(*Dianthus barbatus*, L.)

Mold (*Heterosporium echinulatum*, (Berk.) Cke.) (66)
Rust (*Puccinia Arenariae*, (Schum.) Wint.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 278–280. (1893)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 280. (1893)

Plum.

(*Prunus*, spp.)

Black Knot (*Plowrightia morbosa*, (Schw.) Sacc.)
See Cherry (Black Knot.)
Fire-Blight (Bacterial.)
Occ., Conn. Agr. Exp. Sta., Rep. 18, 1894, pp. 117 & 118. (1895)
Fruit-Mold (*Oidium fructigenum*, Kze. & Schm.)
Descr. Illus., See Cherry (Fruit-Mold.)
Treat. (pos.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 86, pp. 71 & 72. (1895)
Mo. Agr. Exp. Sta., Bull. 31, pp. 16–18. (1895)
Leaf-Curl (*Exoascus mirabilis*, Atk.)
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 19, 1895, pp. 183–185. (1896)
Treat. (pos.), Conn. Agr. Exp. Sta., Rep. 20, 1896, p. 281. (1897)
Leaf-Spot (*Cylindrosporium Padi*, Karst.)
Descr. Illus., N. Y. Agr. Exp. Sta., Rep. 5, 1886, pp. 293–296. (1887)
and Rep. 6, 1887, pp. 347–350. (1888)
Treat. (pos.), U. S. Dep. Agr., Div. Veg. Path., Bull. 7, p. 30. (1894)
N. Y. Agr. Exp. Sta., Bull. 98, pp. 7-12. (1896)
Cf. Cherry (Leaf-Spot.)
Plum-Pockets (*Exoascus Pruni*, Fckl.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 366–369. (1889)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 73, pp. 329 & 330. (1894)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 111. (1893)
Powdery Mildew (*Podosphaera Oxyacanthae*, (DC.) DBy.)
See Cherry (Powdery Mildew.)
Rust (*Puccinia Pruni*, Pers.)
Descr., Journ. Mycol., Vol. VII, pp. 354–356. (1894)
Treat. (pos.), Journ. Mycol., Vol. VII, pp. 356–362. (1894)
Cf. Cherry (Rust.)
Scab (*Cladosporium carpophilum*, Thüm.)
Descr., Journ. Mycol., Vol. VII, pp. 99 & 100. (1892)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 23, pp. 918–920. (1894)
Cf. Cherry and Peach (Scab.)

Poplar.

(*Populus* spp.)

Anthracnose (*Marsonia Populi*, (Lib.) Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 15, 1894, pp. 394–396. (1895)
Rust (*Melampsora populina*, (Jacq.) Lév.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 390–392. (1889)
Treat. (pos.), Mass. (Hatch) Agr. Exp. Sta., Rep. 7, 1894, p. 20. (1895)

Potato.

(*Solanum tuberosum*, L.)

Anthracnose (*Vermicularia* sp.) (67)
Blight (*Bacillus Solanacearum*, Smith.)
See Egg-plant, (Blight.)
Cf. also Miss. Agr. Exp. Sta., Bull. 19. (1892)
Brunissure (*Pseudocommis Vitis*, Debray.) (68)
See Grape, (Brunissure.)
Downy Mildew or Rot (*Phytophthora infestans*, DBy.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 337 & 338. (1889)
N. H. Agr. Exp. Sta., Bull. 22, pp. 3–5. (1894)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 113, pp. 249–254. (1896)
Treat. (pos.), Vt. Agr. Exp. Sta., Bull. 40. (1894)
U. S. Dept. Agr., Farm. Bull. 15, pp. 6 & 7. (1894)
R. I. Agr. Exp. Sta., Bull. 38. (1896)
N. Y. Agr. Exp. Sta., Bull. 123. (1897)
Chytridiose (*Chrysophlyctis endobiotica*, Schilb.) (69)
Dry-Rot (*Fusarium Solani*, (Mart.) Sacc.) (70)
Occ., Ill. Agr. Exp. Sta., Bull. 40, p. 139. (1895)
Internal Browning (Bacterial ?) (71)
Descr., Ill. Agr. Exp. Sta., Bull. 40, pp. 138 & 139. (1895)
N. Y. Agr. Exp. Sta., Bull. 101, pp. 78–83. (1896)
Leaf-Mold or Early Blight (*Alternaria Solani*, (E & M.) Sorauer) (72)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 4, 1891, pp. 58 & 59. (1892)
Vt. Agr. Exp. Sta., Rep. 6, 1892, pp. 66–70. (1893)
Cf. Vt. Agr. Exp. Sta., Rep. 9, 1895, pp. 78–88. (1896)
and Rep. 10, 1896–97, pp. 45–50. (1897)
Treat. (pos.), U. S. Dept. Agr., Farm. Bull. 15, pp. 6 & 7. (1894)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 113, pp. 265–271. (1896)
N. Y. Agr. Exp. Sta., Bull. 123. (1897)
Cf. Conn. Agr. Exp. Sta., Rep. 18, 1894, pp. 127–134. (1895)
Root-Rot (*Entorrhiza Solani*, Fautr.)
See U. S. Dept. Agr., Exp. Sta. Rec., VII–10, p. 873. (1896)

Scab (*Oospora scabies*, Thaxter.) (13)
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 14, 1890, pp. 81-95. (1891)
Also Rep. 15, 1891, pp. 153-160. (1892)
Cf. W. Va. Agr. Exp. Sta., Sp. Bull. 2, pp. 97-111. (1895)
Treat (pos.)
(Cor. Sub.) Mich. Agr. Exp. Sta., Bull. 108, pp. 38-45. (1894)
N. Dak. Agr. Exp. Sta., Bull. 19, pp. 130-134. (1895)
Ind. Agr. Exp. Sta., Bull. 56, pp. 70-80. (1895)
Conn. Agr. Exp. Sta., Rep. 19, 1895, pp. 166-176. (1896)
(Sulphur) N. J. Agr. Exp. Sta., Rep. 16, 1895, pp. 280-282. (1896)
R. I. Agr. Exp. Sta., Bull. 40, pp. 94-96. (1896)
Conn. Agr. Exp. Sta., Rep. 20, 1896, p. 262. (1897)
(Formalin) Ind. Agr. Exp. Sta., Bull. 65. (1897)
Scurf (*Rhizoctonia Solani*, Kühn.) (14)
Stem-Blight (*? Fusarium acuminatum*, Ell. & Ev.)
Descr., N. Y. Agr. Exp. Sta., Bull. 101, p. 85. (1896)
Stem-Rot (*Botrytis cinerea*, Pers.) (15)
Wet Rot (Bacterial.) (16)
Descr., Del. Agr. Exp. Sta., Rep. 4, 1891, pp. 54-57. (1892)
Wilt (*? Oospora rosea*, (Pr.) Sacc. & Vogl.)
Occ., N. Y. Agr. Exp. Sta., Bull. 101, pp. 83 & 84. (1896)

Primrose.

(*Primula* spp.)

Miscellaneous Fungous Diseases. {
Phyllosticta primulicola, Dmz.
Ramularia Primulae, Thm.
Colletotrichum Primulae, Hals.
Ascochyta Primulae, Trail.
See N. J. Agr. Exp. Sta., Rep. 15, 1894, pp. 377-380. (1895)

Privet.

(*Ligustrum vulgare*, L.)

Anthracnose (*Glœosporium cingulatum*, Atkinson.)
Descr. Illus., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 49, pp. 306-314. (1892)

Quince.

(*Pirus Cydonia*.)

Black-Rot (*Sphaeropsis Malorum*, Berk.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 91, pp. 8-10. (1892)
Treat. (rec.), Conn. Agr. Exp. Sta., Bull. 115, pp. 6 & 7. (1893)
Cf. Apple (Black-Rot.)
Fire-Blight (*Micrococcus amylovorus*, Burrill.)
See Apple and Pear (Fire-Blight.)

Leaf-Spot (*Entomosporium maculatum*, Lév.)
  Descr. Illus., See Pear (Leaf-Spot.)
  Treat. (pos.), Conn. Agr. Exp. Sta., Rep. 15, 1891, pp. 150–152. (1892
    N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 80, pp. 619–625. (1894)
Pale-Rot (*Phoma Cydoniae*, Sacc. & Schulz.)?
  Descr. Illus., N. J. Agr. Exp. Sta., Bull. 91, pp. 10 & 11. (1892)
Ripe-Rot or Anthracnose (*Gloeosporium fructigenum*, Berk.)
  See Apple and Grape (Ripe-Rot.)
Rust (*Gymnosporangium* spp., Syn. *Roestelia* spp.)
  Descr. Illus., N. J. Agr. Exp. Sta., Bull. 91, pp. 2–5. (1892)
    N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 80, pp. 625 & 626. (1894)
  Treat. (rec.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 80, p. 627. (1894)

Radish.

(*Raphanus sativus*, L.)

Club-Root (*Plasmodiophora Brassicae*, Wor.)
  Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, pp. 348 & 349. (1891)
  Cf. Cabbage (Club-Root.)
Downy Mildew (*Peronospora parasitica*, (P.) Tul.)
  Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 349. (1891)
  Cf. Cabbage and Turnip (Downy Mildew.)
White Rust (*Cystopus candidus*, (P.) Lév.)
  Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 350. (1891)
  Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 350. (1891)
  Cf. Cabbage and Turnip (White Rust.)

Raspberry.

(*Rubus* spp.)

Anthracnose (*Gloeosporium Venetum*, Speg. = *Gl. necator*, Ell. & Ev.)
  Descr. Illus., U. S. Dept. Agr., Rep. for 1887, pp. 357–360. (1888)
    Ohio Agr. Exp. Sta., Bull. IV–6, pp. 124–126. (1891)
    N. Y. Agr. Exp. Sta., Bull. 124, pp. 262–264. (1897)
  Treat. (rec.), U. S. Dept. Agr., Rep. for 1887, p. 361. (1888)
    (pos.), N. Y. Agr. Exp. Sta., Bull. 124, pp. 265–274. (1897)
Fire-Blight (Bacterial.)
  Descr., Ohio Agr. Exp. Sta., Bull. IV–6, pp. 128 & 129. (1891)
Leaf-Spot (*Septoria Rubi*, Westd.)
  See Blackberry (Leaf-Spot.)
Rust (*Caeoma* (*Uredo*) *luminatum*, Lk.)
  See Blackberry (Rust.)

Rose. (17)

(*Rosa* spp.)

Anthracnose (*Glœosporium Rosae*, Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 14, 1893, pp. 401–405. (1894)
Downy Mildew (*Peronospora sparsa*, Berk.)
Occ., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 282. (1893)
Leaf-Blotch (*Actinonema Rosae*, (Lib.) Fr.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 366–368. (1888)
Treat. (pos.), Mass. (Hatch) Agr. Exp. Sta., Bull. 4, pp. 10 & 11. (1889)
N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 281. (1893)
Leaf-Spot (*Sphaerella rosigena*, Ell.)
Occ., See note (17).
Powdery Mildew (*Sphaerotheca pannosa*, (Wallr.) Lév.)
Descr., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 281. (1893)
Treat. (pos.), Mass. (Hatch) Agr. Exp. Sta., Bull. 4, p. 11. (1889)
N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 281 & 282. (1893)
Rust (*Phragmidium subcorticium*, (Schrank) Wint. and *Ph. speciosum*, Fr.)
Descr. Illus., U. S. Dept. Agr., Rep. for 1887, pp. 369–372. (1888)
Treat. (rec.), U. S. Dept. Agr., Rep. for 1887, pp. 371 & 372. (1888)

Rye.

(*Secale cereale*, L.)

Ergot (*Claviceps purpurea*, Tul.)
Descr. Illus., S. Dak. Exp. Sta., Bull. 33, pp. 40–43. (1893)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 76, p. 20. (1891)
Rust (*Puccinia graminis*, P., and *P. Rubigo-vera*, (DC.) Wint.)
See Oats and Wheat (Rust.)
Smut (*Urocystis occulta*, (Wallr.) Rabh.)
Occ. Illus., Mass. Agr. Exp. Sta., Rep. 9, 1891, p. 247. (1892)
Treat. (pos.), See Oats and Wheat (Smut.)
——— (*Leptosphaeria herpotrichoides*, de Not.) (18)

Salsify.

(*Tragopogon porrifolius*, L.)

Rot (Bacterial.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 351. (1891)
White Rust (*Cystopus Tragopogonis*, Tul.)
Occ., N. J. Agr. Exp. Sta., Rep. 15, 1894, p. 355. (1895)

Shaddock or Grape-Fruit.

(*Citrus Decumana*, Lour.)

See Lemon and Orange.

Sorghum.

(*Sorghum vulgare*, P.)

Blight (*Bacillus Sorghi*, Burrill.)
Descr., Kan. Agr. Exp. Sta., Rep. 1, 1888, pp. 281–301. (1889)
Treat. (rec.), Kan. Agr. Exp. Sta., Rep. 1, 1888, pp. 301 & 302. (1889)
Smut (*Cintractia Sorghi-vulgaris*, (Tul.) Clinton, and *Ustilago Reiliana*, Kühn.)
Descr. Illus., Kan. Agr. Exp. Sta., Bull. 23, pp. 95 & 96. (1891)
Ill. Agr. Exp. Sta., Bull. 47, pp. 374–388. (1897)
Treat. (pos.), Ill. Agr. Exp. Sta., Bull. 47, pp. 405 & 406. (1897)

Spinach.

(*Spinacia oleracea*, Mill.)

Miscellaneous Fungous Diseases.
- Anthracnose (*Colletotrichum Spinaceae*, Ell. & Hals.)
- Downy Mildew (*Poronospora effusa*, (Grev.) Rabh.)
- Leaf-Spot (*Phyllosticta Chenopodii*, Sacc.)
- Scab (*Cladosporium macrocarpum*, Preuss).
- White Smut (*Entyloma Ellisii*, Hals.)

Descr. Illus., N. J. Agr. Exp. Sta., Bull. 70. (1890)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 70, pp. 13 & 14. (1890)

Squash.

(*Cucurbita* spp.)

Anthracnose (*Colletotrichum lagenarium*, (Pass.) Ell. & Hals.)
See Melon (Anthracnose.)
Blight (Bacterial.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 273–276. (1892)
Cf. Squash (Wilt).
Downy Mildew (*Plasmopara Cubensis*, (B. & C.) Humphrey.)
See Cucumber (Downy Mildew.)
Fruit-Mold (*Macrosporium* sp.) (79)
Powdery Mildew (*Erysiphe cichoracearum*, DC.)
Descr. Illus., See Cucumber (Powdery Mildew.)
Treat. (pos.), N.Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 35, p. 330. (1891)
Wilt (*Bacillus tracheiphilus*, Smith.)
See Cucumber (Wilt).

Strawberry.

(*Fragaria* spp.)

Blight (*Micrococcus* sp. ?)
Descr., Mass. (Hatch) Agr. Exp. Sta., Rep. 9, 1896, pp. 59–61. (1897)
Leaf-Blotch (*Ascochyta Fragariae*, Sacc.)
Descr. Illus., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 14, pp. 182 & 183. (1889)
Treat. (rec.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 14, p. 183. (1889)

Leaf-Spot (*Aposphaeria*, sp.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 14, 1893, pp. 329 & 330. (1894)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 14, 1893, pp. 331 & 332. (1894)
Leaf-Spot (*Sphaerella Fragariae*, (Tul.) Sacc.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 334–339. (1888)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 14, pp. 171–181. (1889)
Leaf-Spot (*Sphaerella Fragariae*, (Tul.) Sacc.)
Treat. (pos.), U. S. Dep. Agr., Rep. for 1890, p. 397. (1890)
Ken. Agr. Exp. Sta., Bull. 31, pp. 7–12. (1890)
Md. Agr. Exp. Sta., Rep. 3, 1890, pp. 106–108. (1891)
N. C. Agr. Exp. Sta., Bull. 92, p. 133. (1893)
Conn. Agr. Exp. Sta., Bull. 115, p. 14. (1893)
Powdery Mildew (*Sphaerotheca Castagnei*, Lév.)
Descr., N. Y. Agr. Exp. Sta., Rep. 5, 1886, pp. 291 & 292. (1887)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 239. (1893)
Treat. (rec.), N. Y. Agr. Exp. Sta., Rep. 5, 1886, p. 293. (1887)
Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 243–245. (1893)

Sugar-Cane.

(*Saccharum officinarum*, L.)

——— *Coniothyrium melasporum*, (Berk.) Sacc. (80)
——— *Trichosphaeria Sacchari*, Mass. (81) (83).

Miscellaneous Diseases.
- *Bacillus vascularum*, Cobb. (82)
- *Macrosporium graminum*, Cke. (82)
- *Strumella Sacchari*, Cke. (82) (83)
- *Uromyces Kühnii*, Krüg. (82)
- *Colletotrichum falcatum*, Went. (83)
- *Thielaviopsis ethaceticus*, Went. (83)

Sweet Potato.

(*Ipomœa Batatas*, Lam.)

Black-Rot (*Ceratocystis fimbriata*, Ell. & Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 7–13. (1890)
Journ. Mycol., Vol. VII, pp. 1–9. (1891)
Treat. (pos.), La. Agr. Exp. Sta., Bull. 30, p. 1089. (1894)
(rec.), U. S. Dept. Agr., Farm. Bull. 26, p. 21. (1895)
Java-Rot (*Lasiodiplodia tubericola*, Ell. & Ev.) (84)
Soil-Rot (*Acrocystis Batatas*, Ell. & Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 14–18. (1890)
Treat. (pos.), N. J. Agr. Exp. Sta., Bull. 120, pp. 13–15. (1897)
Stem-Rot (*Nectria Ipomœae*, Hals.)
See Egg-Plant (Stem-Rot.)

Miscellaneous Diseases.
- Dry-Rot (*Phoma Batatae*, Ell. & Hals.)
- Leaf-Spot (*Phyllosticta bataticola*, Ell. & Mart.)
- Scab (*Monilochaetes infuscans*, Ell. & Hals.)
- Soft-Rot (*Rhizopus nigricans*, Ehrb.)
- White-Rot (*Penicillium* sp.)
- White Rust (*Cystopus Ipomœae-panduranae*, (Schw.) Farl.)

Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76. (1890)
Treat. (rec.), U. S. Dept. Agr., Farm. Bull. 26. (1895)

Sycamore.

(*Platanus* spp.)

Anthracnose (*Glœosporium nervisequum*, (Fckl.) Sacc.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 387–389. (1889)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1888, p. 389. (1889)
Cf. Journ. Mycol., Vol. V, pp. 51 & 52.
Gar. & For., X-488, pp. 257 & 258.

Tobacco. (85)

(*Nicotiana Tabacum*, L.)

Brown Spot (*Macrosporium longipes*, Ell. & Ev.)
Descr., Journ. Mycol., Vol. VII, p. 134. (1892)
"Damping-off" (*Alternaria tenuis*, Nees.) (86)
Downy Mildew (*Peronospora Hyoscyami*, DBy.) (87)
Downy Mildew (*Phytophthora Nicotianae*, de Haan.) (88)
Frog-Eye (See Leaf-Blight).
Leaf-Blight (*Cercospora Nicotianae*, Ell. & Ev.)
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 20, 1896, pp. 273–277. (1897)
Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 20, 1896, pp. 277 & 278. (1897)
Mosaic Disease (? Bacterial). (89)
See Journ. Mycol., Vol. VII, pp. 382–385. (1894)
Pole-burn (*Fungi and Bacteria*). (90)
Descr., Conn. Agr. Exp. Sta., Rep. 15, 1891, pp. 168–173. (1892)
Cf. also Rep. 17, 1893, pp. 84 & 85. (1894)
Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 15, 1891, pp. 180–184. (1892)
Powdery Mildew (*Erysiphe lamprocarpa*, (Wallr.) Lév.) (91)
Root-Rot (*Thielavia basicola*, Zopf.) (92)
Stem-Rot (*Botrytis longibrachiata*, Oud.) (93)
Descr., Conn. Agr. Exp. Sta., Rep. 15, 1891, pp. 184 & 185. (1892)
Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 15, 1891, pp. 185 & 186. (1892)
White Speck (*Macrosporium tabacinum*, Ell. & Ev.)
Descr., Journ. Mycol., Vol. VII, p. 134. (1892)
Cf. Conn. Agr. Exp. Sta., Rep. 20, 1896, p. 276. (1897)

Tomato.

(*Lycopersicum esculentum*, Mill.)

Anthracnose (*Colletotrichum phomoides*, (Sacc.) Chester.)
  Descr. Illus., Del. Agr. Exp. Sta., Rep. 4, 1891, pp. 60–62. (1892)
    Cf. Del. Agr. Exp. Sta., Rep. 6, 1893, pp. 111–115. (1894)
  Treat. (rec.), Me. Agr. Exp. Sta., Rep. for 1893, p. 155. (1894)
Blight (*Bacillus Solanacearum*, Smith.)
  See Egg-plant, (Blight.)
  Cf. also Miss. Agr. Exp. Sta., Bull. 19. (1892)
Blight (*Fungus indet.*)
  Descr., Fla. Agr. Exp. Sta., Bull. 21, pp. 25–27. (1893)
  Treat. (pos.), Fla. Agr. Exp. Sta., Bull. 21, pp. 32–36. (1893)
Downy Mildew (*Phytophthora infestans*, DBy.)
  See Potato (Downy Mildew.)
Droop (*Plasmodiophora Tomati*, Abbey.)
  See U. S. Dept. Agr., Exp. Sta., Rec. VI-11, p. 1000. (1895)
Fruit-Mold (*Macrosporium Tomato*, Cke, and *Fusarium Solani*, (Mart.) Sacc.)
  Descr. Illus., U. S. Dept. Agr., Rep. for 1888, pp. 339–344. (1889)
  Treat. (pos.), U. S. Dep. Agr., Sec. Veg. Path., Bull. 11, pp. 61–65. (1890)
  Cf. Vt. Agr. Exp. Sta., Rep. 10, 1896-97, p. 51. (1897)
Leaf-Blight (*Cylindrosporium*, sp.)
  Descr., N. Y. Agr. Exp. Sta., Rep. 14, 1895, p. 529. (1896)
  Treat. (rec.), N. Y. Agr. Exp. Sta., Rep. 14, 1895, pp. 530 & 531. (1896)
Leaf-Mold (*Alternaria Solani*, (E. & M.) Jones.)
  Occ., Del. Agr. Exp. Sta., Rep. 4, 1891, p. 62. (1892)
  See Potato (Leaf-Mold.)
Leaf-Spot (*Septoria* sp.)
  Descr. Illus., Del. Agr. Exp. Sta., Rep. 7, 1894–95, p. 123. (1895)
  Treat. (rec.), Ohio Agr. Exp. Sta., Bull. 73, p. 241. (1897)
Rot (? *Fungus indet.*)
  Descr., N. Y. Agr. Exp. Sta., Rep. 3, 1884, pp. 379 & 380. (1885)
  Cf. Ohio Agr. Exp. Sta., Bull. 73, p. 241. (1896)
    N. Y. Agr. Exp. Sta., Bull. 125, pp. 305 & 306. (1897)
Scab (*Cladosporium fulvum*, Cke.)
  Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 347 & 348. (1889)
  Treat. (pos.), U. S. Dep. Agr., Sec. Veg. Path., Bull. 11, p. 47. (1890)
    Conn. Agr. Exp. Sta., Bull. 115, p. 16. (1893)
Wilt (*Fusarium Lycopersici*, Sacc.) (94)

Turnip.

(*Brassica compestris*, L. and *B. Rapa*, Linn.)

Brown-Rot (*Pseudomonas campestris*, (Pam.) Smith) (95)
  Descr. Illus., Iowa Agr. Exp. Sta., Bull. 27, pp. 130-134. (1895)
Club-Root (*Plasmodiophora Brassicae*, Wor.)
  Descr. Illus., See Cabbage (Club-Root.)
  Treat. (pos.), N. J. Agr. Exp. Sta., Rep. 17, 1896, pp. 304–306. (1897)

Downy Mildew (*Peronospora parasitica*, (P.) Tul.)
Occ., Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 222. (1891)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 223. (1891)
Cf. Cabbage (Downy Mildew.)
Powdery Mildew (*Oidium Balsamii*, Mont.)
Occ., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 61, pp. 305 & 306. (1893)
White Rust (*Cystopus candidus*, P.) Lév.)
Occ., Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 222. (1891)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 223. (1891)
Cf. Cabbage (White Rust.)

Verbena.

(*Verbena* sp.)

Powdery Mildew (*Erysiphe cichoracearum*, DC.)
Occ., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 37, p. 405. (1891)
Treat. (pos.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 37, p. 405. (1891)
Cf. Cucumber and Squash (Powdery Mildew.)

Violet.

(*Viola odorata*, L.)

Anthracnose (*Glœosporium Violae*, B. & Br.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 362. (1891)
Downy-Mildew (*Peronospora Violae*, DBy.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 362. (1891)
Leaf-Blight (*Cercospora Violae*, Sacc.)
Occ. Illus., N. J. Agr. Exp. Sta., Rep. 15, 1894, pp. 384–386. (1895)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 15, 1894, pp. 386–389. (1895)
Leaf-Spot (*Phyllosticta Violae*, Desm.)
Descr., Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 231 & 232. (1893)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 232–235. (1893)
N. J. Agr. Exp. Sta., Rep. 15, 1894, pp. 386–389. (1895)
Root-Rot (*Thielavia basicola*, Zopf.)
Descr., Conn. Agr. Exp. Sta., Rep. 15, 1891, pp. 166 & 167. (1892)
Leaf-Mold (*Zygodesmus albidus*, Ell. & Hals.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 362. (1891)

Watermelon.

(*Citrullus vulgaris*, Schrad.)

Anthracnose (*Colletotrichum lagenarium*, (Pass.) Ell. & Hals.)
Occ., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 326. (1893)
Treat. (neg.), Del. Agr. Exp. Sta., Rep. 5, 1892, p. 79. (1893)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 326–330.
Del. Agr. Exp. Sta., Rep. 5, 1892, pp. 75–79.
Cf. Melon (Anthracnose.)
Downy Mildew (*Plasmopara Cubensis*, (B. & C.) Humphrey.)
See Cucumber (Downy Mildew.)

Leaf-Mold (*Alternaria Brassicae*, Sacc., var. *nigrescens*, Pegl.)
See Melon (Leaf-Mold.)
Leaf-Spot (*Phyllosticta* sp., and (?) *Sphaerella* sp.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 5, 1892, pp. 75–78. (1893)
Wilt (*Fusarium niveum*, Smith.) (96)

Wheat. (97)

(*Triticum vulgare*, L.)

Blight (*Mystrosporium abrodens*, Neum.) (98)
Chytridiose (*Pyroctonum sphaericum*, Prunet.)
See U. S. Dept. Agr., Exp. Sta. Rec., VI–3, pp. 226 & 227. (1894)
Ergot (*Claviceps purpurea*, Tul.)
See Rye (Ergot.)
Mold (*Sphaeroderma damnosum*, Sacc. & Berl.) (99)
Rust (*Puccinia coronata*, Cda., *P. graminis*, P., and *P. Rubigo-vera*, (DC.) Wint.)
Descr. Illus., Ind. Agr. Exp. Sta., Bull. 26. (1889)
Kan. Agr. Exp. Sta., Bull. 38, pp. 1–3. (1893)
Treat. (neg.), Iowa Agr. Exp. Sta., Bull. 16, pp. 326–329. (1892)
Kan. Agr. Exp. Sta., Bull. 46, p. 9. (1894)
Scab (*Cladosporium herbarum*, (Pers.) Link). (100)
Scab (*Fusarium culmorum*, (Smith) Sacc.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 3, 1890, pp. 89 & 90. (1891)
Ohio Agr. Exp. Sta., Bull. 44, pp. 147 & 148. (1892)
Descr., Ind. Agr. Exp. Sta., Bull. 36, pp. 129 & 130. (1891)
Smut (*Tilletia fœtans* (B. & C.) Schrt., *T. Tritici*, (Bjerk.) Wint., and *Ustilago Tritici*, (P.) Jens.)
Descr. Illus., Kan. Agr. Exp. Sta., Rep. 2, 1889, pp. 261-267. (1890)
N. Dak. Agr. Exp. Sta., Bull. 1, pp. 9-20. (1891)
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EXPERIMENTS ON THE FERTILIZATION AND CURING OF TOBACCO. SEASON OF 1897.

By E. H. Jenkins.

Experiments with Fertilizers.

The series of experiments regarding the effect of fertilizers on the quality of wrapper leaf tobacco, which was begun in 1892, was concluded with the crop of 1896.

In 1897, a new series of fertilizer experiments was begun in order to determine whether, on the experiment field, which is typical of a large area of tobacco land in this and neighboring towns, the use of stable manure will produce a finer and more valuable leaf than commercial fertilizers, year after year; if so, whether a smaller dressing of manure supplemented with chemicals will yield the same result, and finally, whether green manuring with a leguminous crop (crimson clover) will answer the same purpose as a dressing of manure.

The crops from the experiment plots were duly harvested and the curing by artificial heat was well advanced, when the tobacco barn and its contents were destroyed by fire.

Experiments in Curing Tobacco.

The method of curing tobacco practiced in this State is well known to Connecticut readers, and others will find it described in the 10th Census of the United States for 1880, Vol. III, p. 831, and briefly outlined in Farmer's Bulletin, No. 60 of the Office of Experiment Stations, U. S. Department of Agriculture. Essentially the same method has been followed from the beginning of the tobacco-growing industry in Connecticut. But because of the call of the trade for a better quality of wrapper leaf and the knowledge of the danger of pole-burn and the way to avoid it, there has been great improvement in the construction of curing barns. Tobacco is no longer cured in open sheds, over stables, or pig pens, but almost universally in barns built specially for the purpose, which can be thoroughly ventilated or tightly closed as the needs of the harvested crop and the exigencies of weather may require.

Nevertheless the curing of the leaf is still quite dependent on the weather. There are few years in which the careful grower is not solicitous regarding his crop, at one time or another, after it is harvested, and watches anxiously for a change of weather.

Much depends on his skill in taking advantage of, or in forestalling changes of this kind, and sometimes it is not possible to escape "pole-burn," a disease, (probably bacterial,) which may destroy a portion or even the whole of the harvested crop, within forty-eight hours of the time when the trouble is first noticed.

The Process of Pole-curing.

The chemical and physiological processes which take place during the curing of the leaf in the tobacco barn are very imperfectly understood. The obvious facts are the evaporation from the leaf of an enormous amount of water, and a change in the color of the leaf. The process, under the most favorable conditions of weather, may be described as follows :

The green leaves of the plant first wilt, losing a great deal of water, and hang down perfectly limp, leaving considerable air spaces between the lath on which the stalks are hung, through which there is a free circulation of air, which is essential to an even, rapid cure. Soon the lower, "sand" leaves turn to a bright yellow color, the tips of the wrapper leaves do the same and yellow patches appear on their surfaces. Later, the sand leaves gradually turn brown and become so dry as to rustle when handled, and the same process goes on gradually through all the leaves of the plant till, last of all, the top leaves come to the same brown color; all this time the "stems", or midribs, of the leaves remain yellow and full of sap and break very easily from the stalk, but on further drying, they turn brown at the point of union with the stalk and knit on to it, so that they are much less easily detached than before. Drying the stems, or midribs, is the last and most tedious part of the pole-curing process. The water dries out of them very slowly, but finally the midribs shrivel together and the cure is complete. The process is seldom finished in less than two months from the start, and after it is done the grower frequently has to wait a long time for a "tobacco storm" to make the leaves moist enough to handle and strip from the stalks.

The Dangers to which Tobacco is exposed during Pole-curing.

The description of the curing process just given, pre-supposes ideal weather during the whole period ; but in almost every year the grower has to combat certain unfavorable weather conditions, so that curing time is an anxious time for all growers. If wet, foggy weather follows harvest, the wilted plants hanging in the barn "full up"; that is, water is drawn from the stalks into the leaves faster than it can evaporate from them, so that the leaves become filled and turgid, and stand off from the stem as they do when growing in the field. This stops the circulation of air between the lath and makes the conditions in the barn favorable to mold or pole-burn. The tobacco soon gets a strong, ugly smell and may either mold, or, at a later stage in the process, may be attacked with pole-burn, which seriously damages or ruins the crop; but if dry weather immediately follows, it takes much longer to wilt the tobacco than it did to wilt it in the first place, because of the blockade of the air passages throughout the barn, and in any case the curing process is retarded.

Another trouble, not so evident during the cure, nor so disastrous in its effects, is "white vein." While its cause is not thoroughly understood, growers generally believe that it results from a too rapid cure, particularly in the purline, when the weather in the early stages of the cure is hot and dry.

A third source of danger, damage and loss, still less commonly regarded than the other two, is a mold of the midrib. During the curing process, the leaf alternately dampens and dries an indefinate number of times, following the fluctuations of the weather, and the midrib, which holds the water longer than the body of the leaf, often molds, and sometimes so badly, that the trouble spreads to the leaf tissue. A little mold is thought nothing of; any considerable amount, however, is a loss to the farmer, because it destroys a portion of the midrib, which would otherwise dampen up at stripping time and increase the weight of the crop. It is, moreover, a damage to the leaf from the packer's point of view, for it infects it with mold spores, which are likely to make the tobacco moldy or musty in the case.

Curing with Artificial Heat.

It is quite certain that pole-burn, white vein and stem mold or rot may be avoided, when the temperature and moisture of the air within the barn—its climate—are properly regulated.

At critical times pole-burn has often been prevented, or its attack mitigated, by putting many lighted kerosene lamps under the hanging tobacco or even kindling small wood fires on the ground.

Artificial heat has long been used at the South for curing certain kinds of tobacco, and when it is used, pole-burn never attacks the crop.

The Modern Tobacco Barn Co., with the use of artificial heat by their patent process, cured a single crop of wrapper leaves, which had been picked from the stalk. This was done in Suffield, Conn. in 1891, and an account of the work is given in the report of this Station for 1891, p. 189. No formal judgment was made of the quality of the cured leaf, but the work of the company in Suffield was discontinued. It is believed by growers that under present conditions it would cost so much to pick the separate leaves by hand as to make this method of curing impracticable even if it yielded a desirable quality of leaf. They also believe that the leaf, if heated to a temperature of 160° F., as in the process referred to, will lose elasticity as well as flavor. During the cure the smell from the tobacco in the barn was almost overpowering when the high temperature prevailed, indicating a loss which is not noticed in curing by the usual method. Artificial heat has not, to our knowledge, been hitherto successfully used to cure wrapper leaf on the stalk.

Experiment at Poquonock.

In 1897, the Connecticut Tobacco Experiment Co. acting with the Station made a trial of curing tobacco on the stalk, using artificial heat, when necessary, to secure an even moist "climate" within the barn, whatever the atmospheric conditions outside might be.

The first experiment was made in a corner "bent", sheathed off from the rest of the curing barn, the partition running from the ground to the roof and making a room 15 feet square. A slat floor was laid, within the curing room, at the height of the barn sills. Beneath was a space of three feet between this floor and the ground. There was laid, on the ground, a sheet iron flue about 8 inches in diameter, running from a stove just outside the building, through to the inner side of the room, along this side, and then back again to the outer side and into a chimney. There were two ventilators in the purline, and two at the bottom below the slat floor. There was also a door by which the curing room could be entered from inside the barn.

The room accommodated the equivalent of 300 pounds of cured leaf and the tobacco was hung in the usual way in four tiers, one of them in the purline.

The tobacco for this test was harvested on Thursday, July 29th, and hung till Saturday the 31st, when the Station representative came to care for the curing. The leaves had "fulled up" somewhat and were not fully wilted. The ventilators were closed and the fire started. From this time till Monday noon, Aug. 2d, the temperature in the room never went over 87° and did not average over 80°, but was tolerably uniform, day and night. The moisture escaped through the cracks and between the battens on the barn, so that during this time the relative humidity averaged 79 per cent. By Monday noon all the leaves were completely wilted and all the ground leaves were of a bright yellow color, except those in the purline; yellow blotches had appeared too on the short wrappers. Outside, the weather was foggy with the wind in the east. From now on till Thursday, Aug. 5th, the fire was kept very low, and water was occasionally sprinkled on the floor of the room. The leaves were judged to be dry enough and were rapidly changing color.

By the 5th the bottom leaves had all come to their proper, light-brown color and were somewhat "husky" to the touch, though they could be handled without breaking. The short wrappers were all yellow and some of them had "come to color," excepting close to the mirdibs and large veins. The long wrappers and top leaves were less advanced.

At the time there was a tremendous down-pour of rain for half a day with an air temperature of a little over 60° outside. Within, the temperature was 10 degrees higher and the relative humidity was 85 to 90 per cent.

As the tobacco was rather dry to the touch, little more heat was used till the 8th, several pails full of water were sprinkled on the floor, the door and ventilators were closed and the leaf allowed to "draw." During this time the cure was still going on and the change in color and texture were evident from day to day.

On the 8th, all the tobacco, including that in the purline, was so moist that none of the cured leaves were at all husky. Heat was applied for three hours and its effect was at once evident in the more rapid change of color from green to yellow and then to brown.

On the 10th, ten days from the start, the barn was heated again for a few hours. All the sand leaves and short wrappers, excepting their midribs, had come to color, a light cinnamon-brown, and their texture and burning quality were pronounced by experts to be excellent. Most but not all of the long wrappers were in the same state. A few of the top leaves still showed green and yellow blotches, being slower to cure. The midribs were also full of sap, though some had turned brown at the point of union with the stem.

On Aug. 12th, heat was again applied for 12 hours and then discontinued, the room was closed, and six or eight pails of water were poured over the floor.

On the 14th, just two weeks from the beginning of the cure, all of the tobacco was carefully examined by Mr. DuBon, Mr. Benj. Haas of Hartford, and Mr. Hartmann of Manchester, the two last named being dealers in leaf tobacco.

It was agreed that the cure, excepting the stems or midribs, which were still "fat," was even, complete and perfectly satisfactory in all parts of the house. The colors were light, glossy brown, the leaf was elastic and had lost none of its life, the burn was all that could be desired. There was nothing about it at all unlike good tobacco, well-cured by the ordinary method. There was no trace of mold on the stem or of white vein.

To finish the drying of the midribs, the room was closed and a moderate fire made every morning which died out in the afternoon. This was continued for a week.

On Aug. 21, three weeks from the beginning of the cure, the midribs were shriveled and dried, the process was complete and the tobacco was ready to bring into condition and take down for casing. This could have been done within two days, but in the mean time the barn was destroyed by fire.

During the first two weeks of the curing, the Station representative staid at the barn day and night almost constantly, and recorded the temperature and relative humidity of the curing-room near the floor and near the top, and of the air outside, every two or three hours, night and day, besides noting the condition of the tobacco from time to time. While the temperature and humidity notes have some interest as showing the range of both, the *only* guide during the process of curing was the look and feel of the leaf itself.

No special skill or knowledge is needed for it beyond what every successful tobacco grower has. We regard the only critical point to be in the first heating.

An immense amount of heat is consumed in the evaporation of water before the leaf is completely wilted, which must be the first step in the curing process; therefore a brisk fire must be kept up till this wilting is accomplished, and if signs of "fulling" appear, *more* heat, rather than less must be applied.

But as soon as the leaf is completely wilted and the change of color in the bottom leaves has begun, the heat must be checked at once, and the leaf closely watched lest the drying be carried too far. The change of color will go on rapidly, and no fire will be necessary probably for some time. If signs of "fulling" appear, a light fire is needed.

The rules which we observed were these: never let the air of the curing-room get as hot as it does sometimes in the purline of the ordinary curing barn. In our room it never went over 88° and seldom over 82°. There can be no "cooking" of the leaf at that temperature.

Keep the heat uniform all through the barn. Our purline averaged only 3 degrees hotter than the lower tiers.

Never let the tobacco get chilled. The lowest point reached in the room was 59° (52½° outside), and the temperature of the curing room in the coolest part of the twenty-four hours, between 3 and 6 A. M., averaged 69°.

Never let the leaves, before they have come to color, dry out so as to be in any part "husky," rustling when touched. They should be perfectly limp, hanging like damp cloths. After coming to color the sand leaves and short wrappers may be allowed to get a little husky but not really brittle.

And finally, keep the cure going on all the time. Don't let it stop, waiting for some change of weather, as it often does, in the usual method of curing.

The result of this experiment was so satisfactory that we determined to cure our experiment crops, referred to on page 223, by the same method, using the barn and the arrangement of flues described in the report of this Station, 1892, p. 36.

The process was found to work even more satisfactorily in the main barn than in the small room, because an even, moderate heat could be more readily maintained and there was less danger, apparently, of over-drying.

The cure was well advanced when the barn took fire, from one of the flues presumably, during the necessary absence of the attendant, and was wholly destroyed. The flues of the curing room, where the first experiment was made, were perfectly secure. The use of the main barn for curing had not been anticipated, and in the hurry of harvesting sufficient attention had not been given—as the event proved—to making these barn flues secure against fire.

EXPERIMENTS IN GROWING TOBACCO WITH DIFFERENT FERTILIZERS.

REPORT ON THE FERMENTED CROPS OF 1896.

CONCLUSION OF THE EXPERIMENTS.

By E. H. Jenkins.

The object of these experiments is to study the effects on the quality of wrapper-leaf tobacco, of certain fertilizers commonly used by our Connecticut growers. Each plot under experiment receives the same fertilizers for a term of years in order to test these fertilizers under the varying climatic conditions which a succession of years affords, and final judgment on the quality of the crops is made after they have been fermented in the case and are ready for manufacture.

The work was begun in 1892 in connection with the Connecticut Tobacco Experiment Company and is concluded with the crop of 1896.

A full description of this experiment will be found in former reports of this Station, viz.: 1892, pp. 1–24; 1893, pp. 112–144; 1894, pp. 254–284; 1895, pp. 128–156; 1896, pp. 285–333.

An account of the growing, harvesting and curing of the crop of 1896 is printed on pages 302 to 309 of the 20th Annual Report of this Station for 1896.

Samples of the long and short wrappers from each plot, with top leaves and seconds sufficient to fill the case, were cased down for fermentation at the warehouse of Mr. L. B. Haas in Hartford, in December, 1896. The case lay undisturbed till Sept. 24th 1897, when it was opened and the samples examined.

SHRINKAGE DURING FERMENTATION.

The tobacco weighed 307 pounds when it was cased. After fermentation it weighed 282 pounds, having lost in the intervening time 25 pounds, or 8.1 per cent.

This loss is less than has been previously observed in our experiments. The percentage losses each year have been, crop of 1892, 13.8 per cent.; of 1893, 14.0; of 1894, 11.1; of 1895, 10.7, and of 1896, 8.1 per cent.

The fermented crop of 1893 was judged by the expert to be "unsweated," while the others were called "well sweated."

JUDGMENT OF THE EXPERT.

Each lot of tobacco was marked with a number, different from the one used in the previous year, and which gave no indication of the plot from which the tobacco came.

The lots were examined and graded by Mr. Benjamin L. Haas of Hartford, who has done the same work each year since beginning the experiment. Mr. Haas devoted two days to the work, and there has thus been secured a perfectly unbiased and intelligent judgment by an expert fully acquainted with the present requirements of the trade.

A strict judgment has been given, noting all defects in the leaf.

The crops on the experiment field were in general of quite as good quality as those grown elsewhere in the neighborhood.

General Remarks. — All the samples of tobacco from the experiment field were ripe and sound.

All, with a single exception, held fire well, and the "burn" of these crops is exceptionally good. The general defects are, the uneven color of the leaves (which as a rule is not light) and the lack of "finish."

Following are the details of the expert's judgment on each sample or lot of tobacco.

LOT A.

Fertilizers: 1423 lbs. cottonseed meal and 1227 lbs. cotton hull ashes per acre, containing 105 lbs. nitrogen, 159 lbs. phosphoric acid and 340 lbs. potash. Cost, $44.50 per acre.

Yield:	835	lbs. long wrappers	per acre.
	265	" short	" "
Total	1100	"	

Quality:—*Burn*, holds fire well, coals slightly. *Ash*, clear white, hard. *Colors*, dark, mottled. *Texture*, well sweated, close grain, dull finish. *Yield*, unprofitable. *Size*, desirable. *Vein*, prominent. *Stem*, small. *Relative rank*, 26th.

LOT B.

Fertilizers: 1562 lbs. linseed meal and 1254 lbs. cotton hull ashes per acre, containing 105 lbs. nitrogen, 143 lbs. phosphoric acid and 340 lbs. potash. Cost, $42.28 por acre.

Yield: 600 lbs. long wrappers per acre.
255 " short " "
Total 855 "

Quality:—*Burn*, holds fire well, does not coal. *Ash*, clear white, hard. *Colors*, medium to dark. *Texture*, well sweated, medium to open grain, fair finish. *Yield*, profitable. *Size*, desirable. *Vein*, small. *Stem*, fine. *Relative rank*, 14th.

LOT C.

Fertilizers: 2371 lbs. cottonseed meal and 1156 lbs. cotton hull ashes per acre, containing 175 lbs. nitrogen, 182 lbs. phosphoric acid and 340 lbs. potash. Cost, $53.99 per acre.

Yield: 815 lbs. long wrappers per acre.
285 " short " "
"
Total 1100 "

Quality:—*Burn*, holds fire well, coals slightly. *Ash*, white, hard. *Colors*, medium to dark. *Texture*, well sweated, open grain, fair finish. *Yield*, fairly profitable. *Size*, medium to large. *Vein*, prominent. *Stem*, medium. *Relative rank*, 9th.

LOT D.

Fertilizers: 2845 lbs. cottonseed meal and 1121 lbs. cotton hull ashes per acre, containing 210 lbs. nitrogen, 195 lbs. phosphoric acid and 340 lbs. potash. Cost, $59.58 per acre.

Yield: 945 lbs. long wrappers per acre.
275 " short " "
Total 1220 "

Quality:—*Burn*, holds fire well, does not coal. *Ash*, clear white, hard. *Colors*, dark, mottled. *Texture*, well sweated, open grain, dull finish. *Yield*, unprofitable. *Size*, medium to large. *Vein*, medium. *Stem*, medium. *Relative rank*, 21st.

LOT E.

Fertilizers: 2225 lbs. castor pomace and 2141 lbs. cotton hull ashes per acre, containing 105 lbs. nitrogen, 152 lbs. phosphoric acid and 340 lbs. potash. Cost, $50.17 per acre.

Yield: 855 lbs. long wrappers per acre.
265 " short " "
Total 1120 "

Quality:—*Burn*, holds fire fairly well, coals very slightly. *Ash*, clear white, hard. *Colors*, dark, mottled. *Texture*, unsweated, close grain, dull finish. *Yield*, unprofitable. *Size*, medium to large. *Vein*, curly. *Stem*, medium. *Relative rank*, 25th.

LOT F.

Fertilizers: 1562 lbs. linseed meal, 509 lbs. cotton hull ashes and 242 lbs. Cooper's bone per acre, containing 105 lbs. nitrogen, 143 lbs. phosphoric acid and 150 lbs. potash. Cost, $28.90 per acre.

Yield: 400 lbs. long wrappers per acre.
215 " short " "
Total 615 "

Quality:—*Burn*, holds fire well, does not coal. *Ash*, clear white, hard. *Colors*, clear, dark. *Texture*, well sweated, open grain, fair finish. *Yield*, fairly profitable. *Size*, desirable. *Vein*, medium. *Stem*, medium. *Relative rank*, 18th.

LOT G.

Fertilizers: 3707 lbs. castor pomace and 1180 lbs. cotton hull ashes per acre, containing 175 lbs. nitrogen, 177 lbs. phosphoric acid and 340 lbs. potash. Cost, $63.62 per acre.

Yield: 815 lbs. long wrappers per acre.
265 " short " "
Total 1080 "

Quality:—*Burn*, holds fire well, does not coal. *Ash*, clear white, hard. *Colors*, clear, dark. *Texture*, well sweated, open grain, fair finish. *Yield*, fairly profitable. *Size*, desirable. *Vein*, prominent. *Stem*, medium. *Relative rank*, 6th.

LOT H.

Fertilizers: 4450 lbs. castor pomace, 1150 lbs. cotton hull ashes per acre, containing 210 lbs. nitrogen, 188 lbs. phosphoric acid and 340 lbs. potash. Cost, $70.37 per acre.

Yield: 940 lbs. long wrappers per acre.
275 " short " "
Total 1215 "

Quality:—*Burn*, holds fire well, coals very slightly. *Ash*, clear white, flakes slightly. *Colors*, medium to light. *Texture*, well sweated, open grain, fair finish. *Yield*, fairly profitable. *Size*, medium to large. *Vein*, light. *Stem*, medium. *Relative rank*, 2d.

LOT I.

Fertilizers: 2225 lbs. castor pomace, 1241 lbs. cotton hull ashes and 656 lbs. nitrate of soda per acre, containing 210 lbs. nitrogen, 152 lbs. phosphoric acid and 340 lbs. potash. Cost, $64.93 per acre.

Yield: 905 lbs. long wrappers per acre.
280 " short " "
Total 1185 "

Quality:—*Burn*, holds fire well, does not coal. *Ash*, clear white, hard. *Colors*, medium to dark, mottled. *Texture*, well sweated, open grain, dull finish. *Yield*, fairly profitable. *Size*, medium to large. *Vein*, prominent. *Stem*, medium. *Relative rank*, 5th.

LOT J.

Fertilizers: 2225 lbs. castor pomace, 1241 lbs. cotton hull ashes and 656 lbs. nitrate of soda per acre, containing 210 lbs. nitrogen, 152 lbs. phosphoric acid and 340 lbs. potash. Cost, $64.93 per acre.

Yield: 865 lbs. long wrappers per acre.
285 " short " "
Total 1150 "

Quality:—*Burn*, holds fire well, does not coal. *Ash*, clear white, hard. *Colors*, clear, dark. *Texture*, well sweated, open grain, dull finish. *Yield*, fairly profitable. *Size*, medium to large. *Vein*, prominent. *Stem*, small. *Relative rank*, 11th.

Lot K.

Fertilizers: 1423 lbs. cottonseed meal, 1182 lbs. double sulphate of potash and magnesia and 396 lbs. of Cooper's bone per acre, containing 105 lbs. nitrogen, 157 lbs. phosphoric acid and 340 lbs. potash. Cost, $40.06 per acre.

Yield: 905 lbs. long wrappers per acre.
285 " short ". "
Total 1190 "

Quality:—*Burn*, holds fire fairly, coals very slightly. *Ash*, clear white, hard. *Colors*, dark, mottled. *Texture*, well sweated, open grain, dull finish. *Yield*, unprofitable. *Size*, medium to large. *Vein*, curly. *Stem*, medium. *Relative rank*, 17th.

Lot L.

Fertilizers: 1423 lbs. cottonseed meal, 1182 lbs. double sulphate of potash and magnesia, 396 lbs. Cooper's bone and 300 lbs. lime per acre, containing 105 lbs. nitrogen, 157 lbs. phosphoric acid and 340 lbs. potash. Cost, $42.04 per acre.

Yield: 645 lbs. long wrappers per acre.
225 " short " "
Total 870 "

Quality:—*Burn*, holds fire well, coals very slightly. *Ash*, clear white, hard. *Colors*, dark, mottled. *Texture*, well sweated, open grain, dull finish. *Yield*, unprofitable. *Size*, medium to large. *Vein*, prominent, curly. *Stem*, heavy. *Relative rank*, 19th.

Lot M.

Fertilizers: 1423 lbs. cottonseed meal, 638 lbs. high grade sulphate of potash and 396 lbs. Cooper's bone per acre, containing 105 lbs. nitrogen, 157 lbs. phosphoric acid and 340 lbs. potash. Cost, $38.28 per acre.

Yield: 655 lbs. long wrappers per acre.
250 " short " "
Total 905 "

Quality:—*Burn*, coals slightly, holds fire. *Ash*, clear white, hard. *Colors*, dark, mottled. *Texture*, poorly sweated, close grain, dull finish. *Yield*, unprofitable. *Size*, desirable. *Vein*, medium. *Stem*, medium. *Relative rank*, 24th.

Lot N.

Fertilizers: 1423 lbs. cottonseed meal, 638 lbs. high grade sulphate of potash, 396 lbs. Cooper's bone and 300 lbs. lime per acre, containing 105 lbs. nitrogen, 157 lbs. phosphoric acid and 340 lbs. potash. Cost, $40.26 per acre.

Yield: 815 lbs. long wrappers per acre.
290 " short " "
Total 1105 "

Quality:—*Burn*, holds fire well, coals slightly. *Ash*, mixed gray. *Colors*, dark, mottled. *Texture*, well sweated, medium close grain, dull finish. *Yield*, unprofitable. *Size*, desirable. *Vein*, medium. *Stem*, medium. *Relative rank*, 22d.

Lot O.

Fertilizers: 1423 lbs. cottonseed meal, 578 lbs. carbonate of potash and 396 lbs. Cooper's bone per acre, containing 105 lbs. nitrogen, 157 lbs. phosphoric acid and 340 lbs. potash. Cost, $71.46 per acre.

Yield: 680 lbs. long wrappers per acre.
290 " short " "
Total 970 "

Quality:—*Burn*, holds fire fairly, coals slightly. *Ash*, mixed gray, hard. *Colors*, dark, mottled. *Texture*, well sweated, medium close grain, dull finish. *Yield*, unprofitable. *Size*, desirable. *Vein*, fine. *Stem*, small. *Relative rank*, 13th.

Lot P.

Fertilizers: 1423 lbs. cottonseed meal, 1724 lbs. double carbonate of potash and magnesia and 396 lbs. Cooper's bone per acre, containing 105 lbs. nitrogen, 157 lbs. phosphoric acid and 340 lbs. potash. Cost, $55.94 per acre.

Yield: 525 lbs. long wrappers per acre.
265 " short " "
Total 790 "

Quality:—*Burn*, holds fire well, does not coal. *Ash*, clear white, hard. *Colors*, medium to dark. *Texture*, well sweated, open grain, fair finish. *Yield*, fairly profitable. *Size*, medium to large. *Vein*, light. *Stem*, medium. *Relative rank*, 7th.

LOT Q.

Fertilizers: 2000 lbs. Baker's AA superphosphate and 4000 lbs. Baker's tobacco manure per acre, containing 238 lbs. nitrogen, 452 lbs. phosphoric acid and 522 lbs. potash.

Yield: 535 lbs. long wrappers per acre.
220 " short " "
Total 755 "

Quality:—*Burn*, does not hold fire, coals. *Ash*, mixed gray. *Colors*, dark, mottled. *Texture*, well sweated, medium close grain, dull finish. *Yield*, unprofitable. *Size*, medium to large. *Vein*, prominent. *Stem*, medium. *Relative rank*, 27th.

LOT R.

Fertilizers: 2000 lbs. Stockbridge tobacco manure per acre, containing 116 lbs. nitrogen, 227 lbs. phosphoric acid and 202 lbs. potash.

Yield: 645 lbs. long wrappers per acre.
225 " short " "
Total 870 "

Quality:—*Burn*, holds fire well, does not coal. *Ash*, clear white, hard. *Colors*, dark, mottled. *Texture*, unsweated, medium open grain, dull finish. *Yield*, unprofitable. *Size*, desirable. *Vein*, prominent. *Stem*, medium. *Relative rank*, 29th.

LOT S.

Fertilizers: 3000 lbs. Stockbridge tobacco manure per acre, containing 174 lbs. nitrogen, 340 lbs. phosphoric acid and 303 lbs. potash.

Yield: 720 lbs. long wrappers per acre.
255 " short " "
Total 975 "

Quality:—*Burn*, holds fire well, coals slightly. *Ash*, mixed gray, hard. *Colors*, medium to dark. *Texture*, well sweated, open grain, dull finish. *Yield*, fairly profitable. *Size*, desirable. *Vein*, prominent. *Stem*, medium. *Relative rank*, 20th.

LOT T.

Fertilizers: 1050 lbs. dry ground fish, 550 lbs. nitrate of soda and 300 lbs. lime per acre, containing 142 lbs. nitrogen and 71 lbs. phosphoric acid. Cost, $32.83 per acre. Total yield, including top leaves and seconds, 1380 lbs. per acre.

Quality:—*Burn*, holds fire well, does not coal. *Ash*, clear white, hard. *Colors*, dark, mottled. *Texture*, well sweated, medium open grain, dull finish. *Yield*, unprofitable. *Size*, desirable. *Vein*, medium. *Stem*, medium. *Relative rank*, 28th.

LOT U.

Fertilizers: 2000 lbs. Mapes' tobacco manure, wrapper brand, per acre, containing 120 lbs. nitrogen, 114 lbs. phosphoric acid and 212 lbs. potash.

Yield: 855 lbs. long wrappers per acre.
255 " short " "
Total 1110 "

Quality:—*Burn*, holds fire fairly well, coals slightly. *Ash*, clear gray, hard. *Colors*, dark, mottled. *Texture*, well sweated, medium close grain, dull finish. *Yield*, unprofitable. *Size*, medium to large. *Vein*, curly. *Stem*, medium. *Relative rank*, 15th.

LOT V.

Fertilizers: 2400 lbs. Mapes' tobacco manure, wrapper brand, and 400 lbs. Mapes' Starter per acre, containing 157 lbs. nitrogen, 190 lbs. phosphoric acid and 268 lbs. potash.

Yield: 743 lbs. long wrappers per acre.
232 " short " "
Total 975 "

Quality:—*Burn*, holds fire well, coals very slightly. *Ash*, mixed gray, hard. *Colors*, mottled, dark. *Texture*, well sweated, medium close grain, dull finish. *Yield*, unprofitable. *Size*, medium to large. *Vein*, medium. *Stem*, medium. *Relative rank*, 16th.

LOT W.

Fertilizers: 2400 lbs. Mapes' tobacco manure, wrapper brand, per acre, containing 145 lbs. nitrogen, 136 lbs. phosphoric acid and 254 lbs. potash.

Yield: 548 lbs. long wrappers per acre.
210 " short " "
Total 758 "

Quality:—*Burn*, holds fire fairly, coals very slightly. *Ash*, mixed gray. *Colors*, medium to dark, mottled. *Texture*, fairly sweated, medium open grain, dull finish. *Yield*, unprofitable. *Size*, medium to large. *Vein*, curly. *Stem*, medium. *Relative rank*, 12th.

LOT X.

Fertilizers: 2000 lbs. Sanderson's formula per acre, containing 88 lbs. nitrogen, 241 lbs. phosphoric acid and 172 lbs. potash.

Yield: 600 lbs. long wrappers per acre.
225 " short " "
Total 825 "

Quality:—*Burn*, holds fire fairly, coals slightly. *Ash*, clear gray. *Colors*, dark, mottled. *Texture*, well sweated, medium close grain, dull finish. *Yield*, unprofitable. *Size*, medium to large. *Vein*, prominent. *Stem*, medium. *Relative rank*, 23d.

LOT Y.

Fertilizers: 1423 lbs. cottonseed meal and 6825 lbs. wood ashes per acre, containing 105 lbs. nitrogen, 150 lbs phosphoric acid and 340 lbs. potash. Cost, $66.79 per acre.

Yield: 635 lbs. long wrappers per acre.
200 " short " "
Total 835 "

Quality:—*Burn*, holds fire well, does not coal. *Ash*, clear white, hard. *Colors*, clear, dark. *Texture*, well sweated, open grain, good finish. *Yield*, fairly profitable. *Size*, desirable. *Vein*, medium. *Stem*, medium. *Relative rank*, 1st.

LOT Z.

Fertilizers: 1260 lbs. dry ground fish, 1211 lbs. double sulphate of potash and magnesia and 256 lbs. Cooper's bone per acre, containing 104 lbs. nitrogen, 86 lbs. phosphoric acid and 340 lbs. potash. Cost, $43.79 per acre.

Yield: 750 lbs. long wrappers per acre.
250 " short " "
Total 1000 "

Quality:—*Burn*, holds fire fairly, coals slightly. *Ash*, white, hard. *Colors*, clear, dark. *Texture*, well sweated, open grain, fair finish. *Yield*, fairly profitable. *Size*, medium to large. *Vein*, medium. *Stem*, medium. *Relative rank*, 4th.

Lot AA.

Fertilizers: 10 to 12 cords stable manure per acre, containing 111 lbs. nitrogen, 71 lbs. phosphoric acid and 149 lbs. potash.

Yield: 650 lbs. long wrappers per acre.
160 " short " "
Total 810 "

Quality:—*Burn*, holds fire well, does not coal. *Ash*, clear white, hard. *Colors*, medium to light. *Texture*, well sweated, open grain, fair finish. *Yield*, fairly profitable. *Size*, medium to large. *Vein*, medium. *Stem*, medium. *Relative rank*, 3d.

Lot BB.

Fertilizers: 3091 lbs. tobacco stems per acre, containing 111 lbs. nitrogen, 36 lbs. phosphoric acid and 486 lbs. potash. Cost, $36.00 per acre.

Yield: 830 lbs. long wrappers per acre.
295 " short " "
Total 1125 "

Quality:—*Burn*, holds fire well, coals slightly. *Ash*, mixed gray, hard. *Colors*, clear, medium to dark. *Texture*, well sweated, open grain, fair finish. *Yield*, profitable. *Size*, desirable. *Vein*, medium. *Stem*, medium. *Relative rank*, 8th.

Lot CC.

Fertilizers: 3000 lbs. Pinney's formula fertilizer per acre, containing 131 lbs. nitrogen, 196 lbs. phosphoric acid and 305 lbs. potash.

Yield: 540 lbs. long wrappers per acre.
245 " short " "
Total 785 "

Quality:—*Burn*, holds fire fairly, coals slightly. *Ash*, mixed gray, hard. *Colors*, medium, mottled. *Texture*, well sweated, medium close grain, fair finish. *Yield*, unprofitable. *Size*, desirable. *Vein*, medium. *Stem*, medium. *Relative rank*, 10th.

The lots of tobacco arranged in order of their value as wrappers are as follows:

Y	H	AA	Z	I	G	P	BB	C	CC	J	W	O
1st (best)	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th
B	U	V	K	F	L	S	D	N	X	M	E	
14th	15th	16th	17th	18th	19th	20th	21st	22d	23d	24th	25th	
A	Q	T	R									
26th	27th	28th	29th (poorest).									

The first, second and third in this list have a higher value than any others, and have practically the same market value. There is very little difference in the value of the lots B, U, V, K, F, L, all of them being more valuable than any of the lots S, D, N, X, M, E, A, which differ little among themselves. Lots Q, T, R, are very much poorer than any others.

Discussion of the Results.

The season of 1896 was favorable to the growth of tobacco. The crop, from setting time to harvest, was in the field 79 days. On 18 or more of those days rain fell, and the longest period during which there was no rain was 13 days. The total rainfall *during the time that the tobacco was on the land* was larger than in any year since 1892, as is shown in the following statement:

In 1892	16.10	inches.
" 1893	6.13	"
" 1894	7.16	"
" 1895	9.38	"
" 1896	11.04	"

Comparative Fire-Holding Capacity.

In the following table is given the relative fire-holding capacity of the long and short wrappers from each plot, determined by Messrs. Winton, Ogden and Mitchell. Five long and five short wrappers were selected from each lot for this purpose and each leaf was tested in six different places, three on each side of the midrib; at the base, near the center and near the tip. For each test the leaf was held horizontally over a "lighter,"—described in the Report for 1892, p. 17—till a circular hole was burned, glowing on the edges. The leaf was quickly removed and the number of seconds was noted, which elapsed till the last spark of fire had gone out from the leaf. The average of the sixty tests was taken to represent the fire-holding capacity of the lot. The lot which held fire the shortest time is marked 100 and the other lots are so marked as to express numerically their capacity for holding fire; for example, the short wrappers from Lot X held fire for a less time than any others (100), while the short wrappers from Lot A held fire more than three times as long (331). The fire-holding capacity of the leaf, as shown in the table, was, in every case, increased by fermentation. The average fire-holding capacity of the crops, during the five years of the experiment, has been as follows :

Crops.	Before Fermentation.	After Fermentation.
Crop of 1892	9.6 seconds.	24.4 seconds.
" 1893	9.0 "	18.0 "
" 1894	9.7 "	23.2 "
" 1895	14.7 "	33.3 "
" 1896	10.1 "	21.4 "

Comparative Fire-Holding Capacity. Fermented Crops, 1896.

Plot.	Long Wrappers.	Short Wrappers.	Calculated from mean of both.	Average number of seconds during which leaf holds fire.	
				Unfermented.	Fermented.
A	257	331	259	16.6	28.5
B	304	279	250	14.5	30.7
C	420	320	313	15.3	34.4
D	250	234	209	10.9	26.1
E	346	236	244	9.8	26.8
F	307	234	229	11.7	25.2
G	262	227	209	10.2	23.0
H	321	242	238	8.4	25.7
I	309	205	215	12.6	23.7
J	276	311	255	13.2	28.1
K	232	174	172	6.9	18.9
L	170	132	127	8.1	14.0
M	245	170	174	7.0	19.1
N	215	138	147	7.0	16.2
O	250	187	185	10.2	20.3
P	431	263	288	10.5	34.5
Q	100	126	100	5.7	11.0
R	197	208	176	9.2	19.4
S	142	131	117	8.3	12.9
T	---	---	---	--	---
U	189	153	145	8.4	15.9
V	180	120	125	10.9	13.8
W	191	210	175	10.5	23.2
X	170	100	112	6.8	12.4
Y	334	236	239	15.0	26.3
Z	177	197	163	8.1	18.0
AA	175	153	140	8.4	15.1
BB	300	199	209	11.1	23.0
CC	185	125	130	6.8	14.3

Number of Fermented Leaves to the Pound.

On p. 309, Report of 1896, is given the number of leaves per pound of each lot of pole-cured tobacco in this crop. The number of leaves per pound of this same crop, after fermentation in the case, appears in the following table. From 25 to 35 leaves were weighed on a balance sensitive to 2 grains, and from these weights the results in the table are computed :

NUMBER OF FERMENTED LEAVES TO THE POUND, CROP OF 1896.

Plot.	Long Wrappers.	Short Wrappers.	Plot.	Long Wrappers.	Short Wrappers.
A	64	113	P	69	105
B	77	110	Q	62	88
C	66	90	R	67	95
D	61	91	S	63	96
E	67	95	T	--	--
F	80	104	U	61	92
G	59	93	V	64	83
H	59	77	W	71	93
I	62	90	X	82	97
J	63	107	Y	74	92
K	65	96	Z	68	99
L	62	99	AA	74	102
M	78	96	BB	65	92
N	77	97	CC	76	98
O	75	103			

The average number of leaves per pound, before and after fermentation, is as follows:—

	Before fermentation	After fermentation.
Long wrappers	62	68
Short wrappers	86	96

RESULTS OF THE EXPERIMENTS WITH TOBACCO FERTILIZERS FOR THE FIVE YEARS, 1892-1896.

By E. H. Jenkins.

The work which has just been described finishes the experiments which were planned in 1892. The results were discussed in the Twentieth Annual Report of this Station for 1896, pp. 310 to 321, and are now briefly summarized, together with the additional facts brought out by the examination of the fermented crop of 1896. The facts regarding the loss of weight during fermentation, weight of leaves, fire-holding capacity and percentage of wrappers, learned from our own experimental crops, are no doubt substantially true of the Connecticut Havana leaf crop in general.

Loss of Weight during Fermentation.

The loss of weight during fermentation, in each of the five years, ranged from 8.1 per cent. to 14 per cent., but the crop which lost most (1893) was called 'poorly sweated,' while all the others were satisfactorily fermented. The character, and not the total amount of the fermentative changes, determines whether the process is successful or not; but, under our present system, it is wholly beyond the power of the owner to control the nature of the fermentation.

Weight of Wrapper Leaves.

The average number of leaves per pound of short and long wrappers, both before and after fermentation, is as follows:

	Before Fermentation.	After Fermentation.
Short Wrappers........ .	87	92
Long Wrappers..........	64	68

These are the averages of all the plots under experiment. The largest number of fermented short wrapper leaves per pound from any one plot was 113; the largest number of fermented long wrapper leaves was 98.

Fire-Holding Capacity.

For this determination six tests were made on each of five leaves, as described on page 241. The average number of seconds during which the wrappers held fire before and after fermentation were as follows:

	Before Fermentation.	After Fermentation.
Short Wrapper Leaves....	12.0	28.5
Long Wrapper Leaves....	9.2	23.9

The fire-holding capacity of the fermented leaves was, generally, more than double that of the unfermented.

Percentages of Wrappers.

The percentages of long and short wrappers in the sorted crops have ranged from 47.2 (1893) to 66.6 (1892), and have averaged 60.7. Certain plots have yielded as high as 78 per cent. of wrappers.

Yield per Acre of Pole-Cured, Sorted Tobacco.

The average yield for all the plots has ranged during the five years from 1568 to 1876 pounds per acre and has averaged 1685 pounds. The maximum yield from any single plot in a single year has been 2280 pounds; the minimum yield, 1145 pounds.

Loss of Weight in Sorting.

The loss of weight in sorting has ranged from 4.6 to 5.3 per cent. of the weight of the crop in the bundle; that is, one thousand pounds of tobacco in the bundle, yielded, on the average, 950 lbs. of sorted tobacco. The extent of this loss depends upon the dampness of the crop when stripped, the length of time it is exposed to drying conditions and the water added during sorting. The best growers avoid, as far as possible, the addition of water to the leaf, either by blowing or sprinkling. Such applications unless very carefully made are apt to spot the leaves and to damage the quality of the tobacco during fermentation.

The Comparative Value of the Leaf from the Several Plots.

The fermented crops from each plot have annually been examined by the expert and all points regarding their quality carefully noted. These notes for each year have been printed in our reports. The decisive test of the comparative value of the several fertilizers must, however, be found in the comparative value of the tobacco raised with their help. This was determined annually by the expert,—a tobacco dealer of experience, who, after careful examination of the samples from all the plots, graded them in the order of their value as wrappers.

When we study the comparative values of the crops from the twenty-nine plots for the five years of experiment, it appears, as was to be expected, that they are not alike in any two years: For example—Of the twenty-nine lots of tobacco, in 1893 P was graded as fourteenth; in 1894, second; in 1895, first; and in 1896, seventh. That is, in 1893 this lot of tobacco was of average quality; in 1894 and 1895 it was the best, or nearly the best, and in 1896 there were only six lots of better quality.

If, now, we average the five numbers representing the grading of the tobacco for each year, in the case before us 14, 2, 1 and 7, we obtain the figure 6.0, which is a numerical expression of the average quality of the crop on this plot for the four years taken together. In like manner we may get a figure expressing the average quality of the crop from each plot for the whole period, the smaller numbers representing higher values.

The numbers expressing the average quality of the tobacco for the five years (lots B, F, P, T, Y, Z, AA, and BB for four years only), as just explained, are here given, arranged in order, the lowest numbers expressing the best quality.

Lot.	Numbers expressing relative quality.	Rank.	Lot.	Numbers expressing relative quality.	Rank.
P	6.0	1st	U	14.0	15th
Y	7.2	2d	G	15.0	16th
Z	7.5	3d	A	15.6	17th
B	7.8	4th	V	15.6	18th
W	8.4	5th	I	16.0	19th
AA	8.5	6th	BB	16.0	20th
H	9.6	7th	L	16 6	21st
F	10.3	8th	R	17.8	22d
C	10.4	9th	N	19.8	23d
O	10.0	10th	X	21.4	24th
D	11.4	11th	Q	23.0	25th
J	12.6	12th	E	24.0	26th
K	13.4	13th	M	24.4	27th
S	13.6	14th	T	25.5	28th

1. EFFECT OF THE QUANTITY OF FERTILIZER-NITROGEN ON THE AMOUNT AND QUALITY OF THE CROP.

Plots A, C, D, E, G and H have received annually, for five years, 340 pounds of potash and from 140 to 190 pounds of phosphoric acid per acre, chiefly in form of cotton hull ashes,* applied at the rate of 1200 pounds per acre.

Plots A, C and D have also received annually cottonseed meal, and plots E, G and H, castor pomace, in such quantities that plots A and E had annually 105 pounds of nitrogen per acre, plots C and G 175 pounds and plots D and H 210 pounds of fertilizer-nitrogen.

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* The only other source of potash and phosphoric acid has been the nitrogenous matter (cottonseed meal or castor pomace), which supplied a comparatively small amount. This large quantity of potash was used because experienced growers suggested it and it agrees with a common practice. We believe the amount is much larger than is generally required. The amount of phosphoric acid, too, is probably largely in excess of the crop requirements, but as it came from the ashes used, the quantity could not be made less without lessening the potash supplied.

From plot D, which received 3000 pounds of cotton seed meal yearly, has been harvested on the average of five years' experiments, a larger weight of wrappers per acre than from plots A and C, which received 1500 or 2500 pounds of cotton seed meal. The gain was large enough to make the use of the larger amount of cotton seed meal profitable, even if the crops sold for 12 cents a pound or less. The average quality of leaf for five years was also better where the larger quantities of cotton seed meal were used.

Like effects followed the use of equivalent quantities of castor pomace. The detailed results appear in Table I.

TABLE I.—EFFECT OF DIFFERENT AMOUNTS OF NITROGEN. AVERAGES OF FIVE YEARS.

	Fertilizer-nitrogen.		Tobacco Crop, pounds per acre.				No. of pole-cured Leaves to pound.		No. of seconds holds fire.		
Plot.	Source of Nitrogen.	Pounds per acre.	Total.	Long Wrap.	Short Wrap.	Percentage of Wrap.	Long Wrap.	Short Wrap.	Long Wrap.	Short Wrap.	Comparative Value.
A	Cotton Seed Meal	105	1615	740	245	61	66	89	14	15	17th
E	Castor Pomace...	105	1760	803	203	60	59	84	10	15	26th
	Average		**1688**	**772**	**224**	**61**	**63**	**87**	**12**	**15**	
C	Cotton Seed Meal	175	1673	795	276	64	61	85	12	14	9th
G	Castor Pomace...	175	1700	769	267	61	62	81	10	13	16th
	Average		**1687**	**782**	**272**	**63**	**62**	**83**	**11**	**14**	
D	Cotton Seed Meal	210	1839	957	268	67	60	85	10	15	11th
H	Castor Pomace ..	210	1863	996	271	68	60	84	10	12	7th
	Average		**1851**	**977**	**269**	**68**	**60**	**85**	**10**	**14**	

2. CAN PART OF A HEAVY DRESSING OF NITROGEN BE ADVANTAGEOUSLY APPLIED IN FORM OF NITRATE OF SODA, DURING THE GROWING SEASON?

Like quantities of cotton hull ashes were applied to plots H, I and J annually for five years. Like quantities of nitrogen (210 pounds) were also put on these three plots, but, while the nitrogen applied to plot H was all in form of castor pomace, plots I and J received only 105 pounds of nitrogen per acre in the form of castor pomace, the other 105 pounds being in the form of nitrate of soda, either in one application (plot J), or in two (plot I). The average yield of tobacco suitable for wrappers was about 45 pounds larger on plot J than on either of the other plots, but its average quality during the five years of experiment was somewhat poorer than on plot H, so that there would appear to be no economy in substituting nitrate of soda for castor pomace, as part of a heavy application of nitrogen. The detailed results appear in Table II.

TABLE II.—EFFECT OF NITRATE OF SODA ADDED DURING THE GROWING SEASON. AVERAGES OF FIVE YEARS.

	Plot H. Castor Pomace.	Plot I. Castor Pomace and Nitrate of Soda.	Plot J. Castor Pomace and Nitrate of Soda.
Amount of Fertilizer-Nitrogen, pounds per acre	210	210	210
Yield of leaf tobacco in pounds, Total	1863	1860	1932
of Long wrappers	996	973	1040
of Short "	271	273	293
Per cent. of wrappers in Crop	68	67	69
No. of pole-cured leaves in 1 pound long wrappers	60	63	65
short "	84	83	80
No. of seconds holds fire, long wrappers	10	9	10
short wrappers	12	15	16
Comparative value	7th	19th	12th

3. COMPARISON OF COTTON SEED MEAL AND CASTOR POMACE AS TOBACCO FERTILIZERS.

Six plots were used for this comparison. The data regarding them are given in Table I. The plots which were dressed with castor pomace yielded more tobacco in the five years' experiment than those dressed with cotton seed meal, the average excess being 111 pounds of sorted tobacco, or 25 pounds of wrappers annually. At the prices which have prevailed, this increase would be enough to make the use of castor pomace profitable, *if the quality of leaf was alike*, but on the average of five years, the quality of leaf raised on cotton seed meal was somewhat better than that of leaf raised on castor pomace. The comparative values of the tobacco raised on the three plots dressed with cotton seed meal were 17th, 9th and 11th. The comparative values of the tobacco raised on the plots dressed with castor pomace were 26th, 16th and 7th.

4. COMPARISON OF LINSEED MEAL WITH COTTON SEED MEAL AND CASTOR POMACE.

(Plot B compared with Plots A and E.)

These experiments were carried out for four years only. The data regarding them appear in Table III. The weight of total crop and of wrappers was decidedly less where linseed was used as a fertilizer, in connection with cotton hull ashes, than where equivalent quantities of cotton seed meal, or of castor pomace were used. The differences in weight of wrappers were 157 pounds, in case of castor pomace, and 65 pounds, in case of cotton seed meal; but the quality of leaf from the plot dressed with linseed was decidedly better than that of leaf from the other two plots. Their relative ranks were, —from the plot dressed with linseed, 5th, from the plot dressed with cotton seed meal, 19th, from the plot dressed with castor pomace, 28th. Plot F, which was dressed with the same amount of linseed as B, but with only half the amount of potash, yielded tobacco which on the average of the four years ranked 9th.

The relative ranks of lots A and E are slightly different from those given in Table I, being calculated, in Table III, for four years instead of five.

TABLE III.—COMPARISON OF LINSEED MEAL WITH COTTON SEED MEAL AND CASTOR POMACE. AVERAGE OF FOUR YEARS.

	Plot B. Linseed Meal.	Plot A. Cotton Seed Meal.	Plot E. Castor Pomace.	Plot F.* Linseed Meal.
Amount of Nitrogen per acre, pounds........	105	105	105	105
Average yield of tobacco in pounds, total....	1501	1585	1740	1600
" " Long wrappers............	664	732	820	669
" " Short wrappers............	222	219	223	260
Per cent. of Wrappers in Crop	59	60	60	58
No of pole-cured leaves in 1 pound				
long wrappers	61	63	57	66
short wrappers........................	85	85	81	91
No. of seconds holds fire, long wrappers.....	12	14	10	9
short "	15	15	15	14
Relative rank..............................	5th	19th	28th	9th

* Dressed with half as much potash as plot B.

5. COMPARISON OF FISH WITH COTTON SEED MEAL AS A TOBACCO FERTILIZER.

(Plot Z compared with Plot K.)

Plots Z and K in 1893, and the following years were dressed with like quantities of bone and double sulphate of potash and magnesia. Each plot also received annually 105 pounds of nitrogen, plot Z in form of dry ground fish, plot K in form of cotton seed meal. The average annual yield per acre from the plot dressed with dry fish as a source of nitrogen has been less than from that dressed with cotton seed meal by about 250 pounds, and the per cent. of wrappers in the crop has been considerably smaller, 56 per cent. from dry fish, 63 per cent. from cotton seed meal. The quality of the leaf raised on Z has, however, been surprisingly good, being graded on the average of the four-year test as 4th, while the tobacco from plot K was graded 17th. The data regarding the crops are shown in Table IV.

TABLE IV.—COMPARISON OF FISH WITH COTTON SEED MEAL AS A TOBACCO FERTILIZER. AVERAGE OF FOUR YEARS.

	Plot Z. Dry Fish.	Plot K. Cotton Seed Meal.
Amount of Nitrogen per acre, pounds	105	105
Average annual yield of tobacco in pounds, total	1496	1740
Long wrappers, pounds	611	879
Short " "	228	217
Per cent. of wrappers in Crop	56	63
No. of polo-cured leaves in 1 pound long wrappers	62	58
short "	82	87
No. of seconds holds fire, long wrappers	7.6	7.6
short wrappers	11.1	9.7
Comparative rank	4th	17th

6. COMPARISON OF STABLE MANURE AND TOBACCO STEMS.

Plots AA and BB were introduced into the experiment in 1893. In 1892, when the other plots were under tillage, these plots were uncultivated and were covered with a sparse growth of poverty grass and blackberry vines. Hence a *strict* comparison of these with the other plots cannot be made.

Plot AA has been dressed annually for four years with mixed yard manure at the rate of 10–12 cords per acre, estimated to supply about 111 pounds of nitrogen, 71 pounds of phosphoric acid and 149 pounds of potash. In 1893 and 1894 it also received 500 pounds per acre of Swift-Sure Superphosphate, containing 15 pounds of nitrogen, 72 pounds of phosphoric acid and 23 pounds of potash.

Plot BB has received in each of the four years 6000 pounds of tobacco stems, containing 111 pounds of nitrogen, 36 pounds of phosphoric acid and 486 pounds of potash. In 1893 and 1894 it likewise received 500 pounds of Swift-Sure Superphosphate.

The yield of tobacco from plot BB (tobacco stems) was an average one (1654 pounds), but from plot AA (stable manure) it was much below the average (1390 pounds), which is fully explained by the low availability of the nitrogen of stable manure. Where ten to twelve cords per acre are used, it should be supplemented by some quickly available form of nitrogen, like cotton seed meal. On the average of four years the tobacco from AA (manure) was graded 6th, that from BB (stems) 18th, while that from the three plots dressed with cotton seed meal and cotton hull ashes was graded 19th, 10th, 12th.

The data regarding the crops are shown in Table V.

TABLE V.—STABLE MANURE COMPARED WITH COTTON SEED MEAL AND TOBACCO STEMS. AVERAGE OF FOUR YEARS.

	Plot A. Cotton Seed Meal and Cotton Hull Ashes.	Plot AA. Stable Manure.	Plot BB. Tobacco Stems.
Average yearly yield of leaf-tobacco, pounds per acre	1585	1390	1654
Average yearly yield of long wrappers, pounds per acre	733	470	745
Average yearly yield of short wrappers, pounds per acre	219	211	231
Per cent. of wrappers in crop	60	49	59
No. of pole-cured leaves in 1 pound of long wrappers	63	64	67
No. of pole-cured leaves in 1 pound of short wrappers	85	74	85
No. of seconds holds fire, long wrappers	14	10	10
No. of seconds holds fire, short wrappers	15	12	12
Comparative rank	19th	6th	18th

7. COMPARISON OF THE EFFECTS OF VARIOUS FORMS OF POTASH ON THE QUALITY OF THE CROP.

(Plots A, K, L, M, N, O, P, Y.)

All of the plots in this series were dressed each year with 105 pounds of nitrogen per acre, in form of cotton seed meal (about 1500 pounds per acre).

All were likewise dressed annually with 340 pounds per acre of potash, *but in different forms.* Thus A received cotton hull ashes; K, double sulphate of potash and magnesia; L, double sulphate of potash and magnesia, *with lime* at the rate of 300 pounds per acre; M, high grade sulphate of potash; N, high grade sulphate of potash and magnesia, *with lime* at the rate of 300 pounds per acre; O, carbonate of potash; P, double carbonate of potash and magnesia; and Y, wood ashes.

Plots A and Y received about 150 pounds of phosphoric acid annually per acre, chiefly in the ashes. The like quantity was supplied to the other plots in form of Cooper's bone.

Plots O, P, Y and A, to which the potash was applied in some form of carbonate, yielded 1549, 1416, 1482 and 1615 pounds of sorted tobacco, respectively, considerably less than the average, 1685 pounds. The other plots named, which received potash in form of sulphate, yielded more than the average. The tobacco from plots K, L, M and N, all of which were dressed with potash in form of sulphate, had slightly heavier leaves and did not hold fire quite as long as the others in this series which received potash in some form of carbonate.

In general, the crops from plots which were dressed with carbonate of potash in form of pure carbonate of potash, wood ashes, double carbonate of potash and magnesia and cotton hull ashes, were of better average quality than those from plots dressed with forms of sulphate of potash, either with or without lime, as appears in the following statement:

TABLE VI.—COMPARISON OF THE EFFECTS OF VARIOUS FORMS OF POTASH AS TOBACCO FERTILIZERS

	Plot A.	Plot K.	Plot L.	Plot M.	Plot N.	Plot O.	Plot P.*	Plot Y.*
Source of Potash.	Cotton Hull Ashes.	Double Sulphate of Potash and Magnesia.	Double Sulphate of Potash and Magnesia with Lime.	High Grade Sulphate of Potash.	High Grade Sulphate of Potash with Lime.	Carbonate of Potash.	Double Carbonate of Potash and Magnesia.	Wood Ashes.
Yield of Tobacco per acre	1615	1776	1664	1709	1690	1549	1416	1482
Long wrappers	740	874	705	653	742	672	601	631
Short wrappers	241	277	277	253	272	257	263	199
Per cent. of wrappers in crop	61	65	59	53	60	60	61	56
No. of pole-cured leaves in 1 lb. long wrappers	66	60	63	67	64	70	66	69
No. of pole-cured leaves in 1 lb. short wrappers	89	82	87	86	85	89	87	91
No. seconds holds fire, long wrappers	14	8	8	7	8	10	13	12
short wrappers	15	10	10	10	11	14	12	17
Relative rank	17th	13th	21st	27th	23d	10th	1st	2d

* Four years' test.

TOBACCO RAISED ON MIXED FERTILIZERS SUPPLIED BY MANUFACTURERS.

Plot Q received per acre annually for five years, 2000 pounds of AA Superphosphate and 4000 pounds of Baker's Tobacco Manure, made and supplied by H. J. Baker & Bro. of New York. The two supplied 238 pounds of nitrogen, 452 pounds of phosphoric acid and 522 pounds of potash.

Plot R received per acre annually 2000 pounds of Stockbridge Tobacco Manure and 500 pounds of the same, used as a starter. The two supplied 154 pounds of nitrogen, 307 pounds of phosphoric acid and 278 pounds of potash.

Plot S received in 1892, 4000 pounds per acre of Bowker's Tobacco Manure. In 1893 and each succeeding year, 3000 pounds of Stockbridge Tobacco Manure and 500 pounds of Stockbridge Tobacco Starter were used, the two containing 209 pounds of nitrogen, 393 pounds of phosphoric acid and 396 pound of potash.

The fertilizers for plots R and S were made and supplied by the Bowker Fertilizer Co. of Boston and New York.

Plot U received in 1892, per acre, 500 pounds of lime, 500 pounds of Mapes' Tobacco Starter and 2600 pounds of Mapes' Wrapper Brand Tobacco Manure. In 1893 and the following years it received 600 pounds per acre of Mapes' Tobacco Starter and 2200 pounds of Mapes' Wrapper Brand Tobacco Manure, the two containing 158 pounds of nitrogen, 211 pounds of phosphoric acid and 278 pounds of potash.

Plot V received per acre in 1892, 500 pounds of lime, 500 pounds of Mapes' Tobacco Starter and 2600 pounds of Special Tobacco Manure. In 1893 it received 800 pounds of Starter and 2000 pounds of Mapes' Wrapper Brand Tobacco Manure. In 1894 and the following years it received 400 pounds of Starter and 2400 pounds of Wrapper Tobacco Manure. These supplied 163 pounds of nitrogen, 196 pounds of phosphoric acid and 294 pounds of potash.

Plot W received per acre in 1892, 500 pounds of lime, 500 pounds of Tobacco Starter and 2600 pounds of Special Tobacco Manure. In 1893 it received 1000 pounds of Starter and 1800 pounds of Wrapper Tobacco Manure. In 1894 and the following years it received 2400 pounds of Wrapper Tobacco Manure, supplying 151 pounds of nitrogen, 143 pounds of phosphoric acid and 280 pounds of potash.

The fertilizers for plots U, V and W were made and supplied by the Mapes' Formula and Peruvian Guano Co. of New York City.

Plot X received per acre in 1892, 6000 pounds of Sanderson's Tobacco Manure, and in 1893 and each of the following years it received 2000 pounds of the same brand of fertilizer, supplying 103 pounds of nitrogen, 281 pounds of phosphoric acid and 105 pounds of potash.

The fertilizers for this plot were made and supplied by L. Sanderson, New Haven.

The results of this series are given in the following table, and are submitted without further comment.

TABLE VII.—EFFECTS OF FERTILIZERS MADE AND SUPPLIED BY THE FIRMS NAMED.

Name of Manufacturer. Plot.	Baker. Q.	Bowker. R.	Bowker. S.	Mapes. U.	Mapes. V.	Mapes. W.	Sanderson X.
POLE-CURED CROP.							
Total crop, pounds per acre	1892	1614	1770	1991	1624	1600	1605
Long wrappers, " "	896	673	893	1039	796	764	755
Short " " "	252	247	273	256	226	228	240
Per cent of wrappers	61	57	66	65	63	62	62
No. of long wrapper leaves per pound..............	58	64	61	59	61	63	61
No. of short wrapper leaves per pound..............	80	73	86	77	86	94	86
Holds fire, seconds, long wrappers	6.0	9.0	8.0	7.0	8.0	10.0	6.0
Holds fire, seconds, short wrappers	7.0	11.0	12.0	10.0	12.0	12.0	7.0

The relative rank of the tobacco from these plots, during the past five years, has been :—

							For the five years together.
Q	Baker's......	15th,	20th,	29th,	24th,	27th,	25th
R	Bowker's	13th,	17th,	23d,	7th,	29th,	22d
S	"	11th,	7th,	22d,	8th,	20th,	14th
U	Mapes'	20th,	4th,	18th,	13th,	15th,	15th
V	"	24th,	11th,	24th,	3d,	16th,	18th
W	"	18th,	2d,	8th,	2d,	12th,	5th
X	Sanderson....	21st,	27th,	9th,	27th,	23d,	24th

These experiments in the application of fertilizers to tobacco have been carried out for five years with all the care and skill at our command. Certain questions regarding the effects of a number of fertilizer materials, which have been vainly discussed for a long time, have been answered by these experiments as completely and definitely as is in the nature of things possible.

One fact, emphasized by our experience, is that there is no "best" tobacco fertilizer or "best" formula for all seasons even on the same soil. A formula or a form of plant food which in one season gives to the leaf a somewhat better quality than any other, may, perhaps the next year and on the same soil, prove inferior to others for reasons which can only be surmised.

Nevertheless by comparing the effects of these fertilizers for a term of years, it appears that certain ones are on the whole and, generally speaking, more likely to impart a perfectly satisfactory quality to the leaf than certain others.

The opinions of growers regarding tobacco fertilizers are widely divergent and the prejudices of both growers and dealers are sometimes strong. Thus certain growers declare that they would not use stable manure on tobacco if it cost them nothing to use it; others would use nothing else if they could buy enough manure.

In 1897 the only tobacco which remained green through the growing season and ripened normally,—while all other tobacco in the field turned yellow and was certainly injured by the excessive rainfall,—was that grown on the plot which annually for five years had been dressed with 10–12 cords of stable manure per acre. (Plot AA, the yield of which was graded 13th, 1st, 17th and 3d in four successive years.)

Certain dealers refuse to buy crops from land on which linseed meal was used. The results of our four years' tests show no ground for this objection; see page 248.

Some growers believe that castor pomace is greatly superior to cotton seed meal as a fertilizer; others condemn pomace. Yet careful comparison for five years fails to show any great difference in their effects, (page 248.) The summary given on previous pages will show other illustrations of the fact: that on this soil, typical of much of our tobacco land, careful experiments managed by a skillful and successful grower and with all facilities for accurate work, do not justify many of the opinions of growers and dealers regarding the effects of different forms of plant food on the quality of wrapper tobacco.

It is doubtless true of tobacco as of other crops that the liberal but not greatly excessive supply of readily available plant food yearly required to ensure a paying crop, may be given in a variety of forms with equally good results on the average of one season with another, and that indeed occasional changes in the form of nitrogen and potash supplied may be a distinct advantage; avoiding always any considerable quantity of those things, chlorine and sulphuric or other free acids, which experience has shown may damage the leaf.

We believe that the methods of pole-curing and fermentation of the crop now require study more than the problem of fertilization.

EXPERIMENTS ON THE AVAILABILITY OF FERTILIZER-NITROGEN.

By S. W. Johnson, E. H. Jenkins and W. E. Britton.*

These experiments are a continuation of work done in previous years on the same subject, which is described in the Station Reports: 1885, pp. 115–132; 1886, pp. 80–89; 1893, pp. 218–237; 1894, pp. 73–112; 1895, pp. 99–116; 1896, pp. 178–204.

I. Cultures of Oats followed by Hungarian Grass, in a Natural Soil, 1897.

Pots Nos. 5 to 195.

In these cultures the following materials are compared with reference to the availability of their nitrogen: nitrate of soda, dried blood, horn and hoof, fish, tankage, bone, cotton seed meal, linseed meal, castor pomace.

The Apparatus and Method.

The cultures were made in cylindrical pots of galvanized iron, eight inches in diameter and twelve inches deep. For ventilation and for use in watering the soil, each pot was provided with a glass tube which reached from top to bottom of the pot, the soil being packed about it.

These pots were set up in a glass house where they were protected from rain, wind and insects and freely ventilated. This house is figured and described in the Station Report, 1894, p. 75.

Soil and Fertilizers.

The soil for these experiments was taken from the surface of plot D in the field experiment on the growth of maize, which is described in the Twentieth Report of this Station for 1896, pp. 335–341. The soil, a sandy loam, on which maize had grown for eight years and to which neither manure nor fertilizer chemicals had been applied for six years, was sifted through a wire screen with four meshes to the inch and mixed by careful and repeated shoveling.

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* These investigations were planned, and the results prepared for publication, by the Director and Vice-Director. The filling of the vegetation pots, the care of them during growth and the harvesting have been wholly in Mr. Britton's charge. The analyses of the fertilizers used and of the crops harvested, have been made by the station chemists, Messrs. Winton, Ogden and Mitchell.

With the twenty-five pounds of soil, which each pot received, were carefully mixed 50 grams of calcium carbonate, 5 grams of potassium phosphate—containing 0.1971 gram of phosphoric acid and 0.2629 gram of potash—and the quantity of nitrogen which is given in Table I. This mixture was filled into the pot in successive portions and each portion was pressed down gently, so that all the pots were filled to the same depth and as nearly as possible with the same compactness. The pots were filled on the 28th, 29th and 30th of April. After filling, the amount of water in the soil, originally 10.5 per cent., was increased by watering to 12 per cent.

Nitrogenous Matters used in the Experiments of 1897.

With exception of the ground horn and hoof all these materials were bought in our local fertilizer market and with exception of nitrate of soda and ground bone, were a part of the same stock from which last year's tests were made; the slight differences between the percentages of nitrogen found in 1896 and 1897 being probably due to changes of water content.

The blood was black, probably kiln-dried.

The cotton seed meal was prime decorticated yellow meal, such as is commonly used for a feed or fertilizer.

The ground horn and hoof was brittle, easily pulverized, and is stated to be prepared in Chicago by steam-heating.

The bone was a clean, raw knuckle bone.

The tankage represented the grade of "bone tankage" commonly found in market.

The castor pomace and dry ground fish were of the usual quality.

Before use all these materials were ground to pass a sieve with circular holes $\frac{1}{50}$ inch in diameter.

The percentages of nitrogen were as follows:

Nitrate of Soda	contained	15.45	per cent	of nitrogen.
Dried Blood	"	13.73	"	"
Dry Ground Fish	"	9.63	"	"
Ground Horn and Hoof	"	15.27	"	"
Bone Tankage	"	4.88	"	"
Bone	"	3.64	"	"
Collier Castor Pomace	"	4.75	"	"
Cotton Seed Meal	"	8.32	"	"
Linseed Meal	"	6.44	"	"

A. OAT CROP.

SEED AND PLANTING.

Seed oats of medium and nearly uniform size were carefully selected, soaked for about twelve hours in warm water and placed in a germinating apparatus on May 4th. On May 10th ten germinated oats were laid on the surface of the soil in each pot and covered with two pounds of the same kind of soil with which the pots had been charged, but without any mixture of fertilizers. The water content of the whole amount of soil was brought to 15 per cent. by adding water on the surface.

OAT CROP. CARE DURING GROWTH.

On May 14th the first oat plants came up and on the 15th some had appeared in each pot.

When the oats were a few inches high, the soil of each pot was mulched with coarse moss peat to hinder evaporation. The soil was watered partly on the surface and partly at the bottom through the glass tube already referred to, so as to keep the water content—making no allowance for the weight of the crop—between 15 and 10 per cent., as ascertained by weighing.

Beginning with June 24th, when the first heads appeared on the oats, the quantity of water added was increased, so that, *making no allowance for weight of crop*, the soil contained 20 per cent. of water immediately after watering and not less at any time than 15 per cent. This increase was designed to offset the increasing weight of the fresh crop.

By July 13th all the plants had headed and the lower leaves of all were ripening and turning brown.

All the crops made good growth and had a thrifty appearance throughout the season. It was necessary to fumigate the vegetation house once to destroy plant lice which attacked the seed heads.

There was very little difference in the height of the plants in the several pots, and the number of stalks coming from the ten plants which grew in each pot was fairly uniform in those pots to which the same form of nitrogen had been added in like amounts. (Thus in the castor pomace series, pots 186, 187 and 188, which received 1.6 grams of fertilizer nitrogen, yielded respectively 27, 26 and 30 stalks; pots 189, 190, 191 and 192 with 1.2 grams of fertilizer-nitrogen, yielded 27, 27, 23 and 26 stalks, and pots 193, 194 and 195, with 0.8 gram fertilizer-nitrogen, yielded 29, 20 and 21 stalks.) But there were marked differences in the number of stalks produced in pots differently fertilized.

Thus the plants fertilized with nitrate, fish, or castor pomace, had an average of 26 stalks; fertilized with blood, or horn and hoof, 25 stalks; with linseed, 24 stalks; with cotton seed meal or tankage, 23 stalks; with bone, 15 stalks; while the plants in pots to which no nitrogenous fertilizer was added, yielded only 12 stalks.

Oat Crop. Harvest, Weighing and Analysis.

On August 6th the crops were harvested. Each was separated into three parts: 1, the clean grain; 2, the chaff, stalks and leaves, and 3, the roots. These last were separated from the soil as fully as possible by passing all the soil in the pot through a sieve.

Each sample was dried by artificial heat, allowed to stand for forty-eight hours thereafter at ordinary temperature in a rather dry place, and then was weighed, and nitrogen determined in it.

B. Crop of Hungarian Grass.

Seed and Planting.

The earth was filled into the pots again without further addition of fertilizers, and fifteen seeds of Hungarian grass were planted in each pot, on August 19th, without previous germination. Some of the seeds failed to yield healthy plants and the crops were attacked by cut worms, which did considerable damage.

To replace this loss more seeds were planted, but it was not possible to get the same number of sound plants in each pot. This, however, was not deemed to be essential, as the quantity of nitrogen at the disposal of the crop was known to be less than a small number of plants could consume.

Crop of Hungarian Grass. Harvest.

All of the crops, except those which were replanted, had fully headed on September 25th and on November 9th all the crops were harvested. The plants from each pot were not separated into roots, seed heads and stalks with leaves, as was done with the oat plants, but the whole crop, roots, stalks, leaves and seed was harvested and ground together, making a single sample.

TABLE I.—VEGETATION EXPERIMENTS IN SANDY LOAM, 1897.

AVAILABILITY OF NITROGEN TO OATS AND HUNGARIAN GRASS.

No. of Pot.	Source of Fertilizer Nitrogen.	Quantities of Fertilizer-Nitrogen (grams).	Oat Crop.		Hungarian Grass Crop.		Total Weights of both Crops, air dry (grams).	Total Weights of Nitrogen in both Crops (grams).	Increase of Crop-Nitrogen over Average Crop-Nitrogen of Pots 5 to 13.	Nitrogen-Increase expressed in Percentages of Fertilizer-Nitrogen. Percentage Availability.	Average Percentage Availability.
			Weights of Crops air dry (grams).	Weights of Nitrogen in Crops (grams).	Weights of Crops air dry (grams).	Weights of Nitrogen in Crops (grams).					
5	None used	..	59.97	0.5001	28.70	.2870	88.67	.7871			
6	" "	..	73.82	0.5389	12.90	.2025	86.72	.7414			
7	" "	..	65.57	0.5220	24.40	.2806	89.97	.8026			
8	" "	..	60.02	0.5068	23.20	.2607	83.22	.7675			
9	" "	..	52.52	0.4884	12.80	.2112	65.32	.6996			
10	" "	..	52.95	0 4842	32.40	.2883	85.35	.7725			
11	" "	..	75.75	0.5338	18.05	.1588	93.80	.6926			
12	" "	..	59.05	0.5223	29.20	.2803	88.25	.8026			
13	" "	..	52.80	0.4617	15.20	.2158	68.00	.6775			
15	Nitrate of Soda	1.6	78.45	1.4378	9.50	.1454	87.95	1.5832	0.7339	45.8*	(79.6)
16	" "	1.6	116.60	1.5531	36.50	.5256	153.10	2.0787	1.3294	83.1	
17	" "	1.6	95.50	1.5761	30.40	.3891	125.90	1.9652	1.2159	75.9	
18	" "	1.2	115.60	1.3833	32.50	.4095	148.10	1.7928	1.0436	86.9	(89.3)
19	" "	1.2	88.61	1.4019	46.30	.4399	134.91	1.8418	1.0925	91.0	
20	" "	1.2	94.50	1.4612	24.80	.3596	119.30	1.8208	1.0715	89.2	
21	" "	1.2	104.50	1.5560	18.40	.2650	122.90	1.8210	1.0817	90.1	
23	" "	0.8	96.90	1.3534	23.40	.2527	120.30	1.6061	0.8568	107.1	102.5
24	" "	0.8	109.75	1.2771	26.70	.2777	136.45	1.5548	0.8055	100.6	
25	" "	0.8	95.57	1.2827	19.00	.2641	114.57	1.5468	0.7975	99.6	
26	Blood	1.6	100.45	1.4178	27.90	.3571	128.35	1.7749	1.0256	64.1	(65.1)
27	"	1.6	99.26	1.5016	27.50	.3795	126.75	1.8811	1.1318	70.8	
102	"	1.6	91.64	1.3210	34.30	.3979	125.94	1.7189	0.9696	60.6	
103	"	1.2	109.80	1.3785	24 20	.3001	134.00	1.6786	0.9293	77.4	73.1
104	"	1.2	119.75	1.3596	25.40	.2921	145 15	1.6517	0.9024	75.2	
105	"	1.2	113.77	1.3456	3.20	.0614	116.97	1.4070	0.6577	54.8*	
106	"	1.2	93.41	1.2195	28.30	.3311	121.71	1.5506	0.8013	66.8	
107	"	0.8	103.85	1.0425	35.50	.3409	139.35	1.3834	0.6341	79.3	77.3
108	"	0.8	123.24	1.1084	23.90	.2486	147.14	1.3570	0.6077	76.0	
109	"	0.8	103.24	1.0917	23.10	.2703	126.34	1.3620	0.6127	76.6	
110	Fish	1.6	98 85	1.4523	16.60	2689	115.45	1.7212	0.9719	60.8	(60.3)
111	"	1.6	89.70	1.4328	27.40	.3261	117.10	1.7589	1.0096	63.1	
112	"	1.6	100.62	1 3835	17.60	.2781	118.22	1.6616	0.9123	57.0	
113	"	1.2	123.20	1.2830	20.90	.3658	144.10	1.6488	0.8995	75.0	67.3
114	"	1.2	103.65	1.2827	25.10	.3188	128.75	1.6015	0.8522	71.0	
115	"	1.2	94.42	1.2090	23.20	.2993	117.62	1.5083	0.7590	63.3	
116	"	1.2	100.82	1.2767	9.80	.1921	110 62	1.4688	0.7195	60.0	
117	"	0.8	100.62	1.0415	20.65	2540	121.27	1.2955	0.5462	68.3	63.6
123	"	0.8	106.55	1.0151	16.80	.1915	123.35	1.2066	0.4573	57.2	
124	"	0.8	101.92	0.9933	22.65	.2786	124.57	1.2719	0.5226	65.3	

* Excluded from the average.

TABLE I.—VEGETATION EXPERIMENTS IN SANDY LOAM, 1897.—*Continued.*

AVAILABILITY OF NITROGEN TO OATS AND HUNGARIAN GRASS.

No. of Pot.	Source of Fertilizer Nitrogen.	Quantities of Fertilizer-Nitrogen (grams).	Oat Crop.		Hungarian Grass Crop.		Total Weights of both Crops, air dry (grams).	Total Weights of Nitrogen in both Crops (grams).	Increase of Crop-Nitrogen over Average Crop-Nitrogen of Pots 5 to 18.	Nitrogen-Increase expressed in Percentages of Fertilizer-Nitrogen. Percentage Availability.	Average Percentage Availability.
			Weights of Crops air dry (grams).	Weights of Nitrogen in Crops (grams).	Weights of Crops air dry (grams).	Weights of Nitrogen in Crops (grams).					
125	Bone	1.6	73.17	0.6972	17.25	.2467	90.42	0.9439	.1946	12.1*	----
126	"	1.6	82.67	0.6624	23.95	.4167	106.62	1.0791	.3298	20.6*	
127	"	1.6	69.97	0.6498	11.10	.1454	81.07	0.7952	.0459	2.9*	
128	"	1.2	87.20	0.6237	33.40	.3206	120.60	0.9443	.1950	16.3	18.3
129	"	1.2	90.99	0.7016	20.70	.2484	111.69	0.9500	.2007	16.7	
130	"	1.2	77.45	0.6487	14.30	.1945	91.75	0.8432	.0939	7.8*	
135	"	1.2	87.68	0.6631	23.00	.3496	110.68	1.0127	.2634	21.9	
136	"	0.8	87.17	0.6181	20.20	.2444	107 37	0.8625	.1132	14.2	16.1
137	"	0.8	76.95	0.5886	25.30	.2707	102.25	0.8593	.1100	13.8	
142	"	0.8	67.05	0.5826	29.50	.3304	96.55	0.9130	.1637	20.5	
143	Tankage	1.6	87.50	1.2471	23.50	2867	111.00	1.5338	.7845	49.0	49.8
144	"	1.6	99 32	1.2383	32.40	3337	131.72	1.5720	.8227	51.4	
145	"	1.6	99 72	1.1875	30.10	.3431	129.82	1.5306	.7813	48.8	
146	"	1.2	101.20	1.0324	26.60	.2766	127.80	1.3090	.5597	46.6	48.8
147	"	1.2	102.23	1.1049	28.50	.3021	130.73	1.4070	.6577	54.8	
151	"	1.2	89.13	1.0304	19.70	.2600	108.83	1.2904	.5411	45.1	
152	"	1.2	100 65	1.0310	22.40	.3046	123.05	1.3356	.5863	48.9	
153	"	0.8	97.69	0.8412	11.60	.1868	109.29	1.0278	.2785	34.8*	53.4
154	"	0.8	103.94	0 9105	28.30	3113	132.24	1.2218	.4725	59.1	
155	"	0.8	101.19	0.8900	25.90	.2409	127.09	1.1309	.3816	47.7	
156	Horn and Hoof	1.6	105.77	1.4660	18.40	.2962	124.17	1.7622	1.0129	63.3	(68.8)
157	" "	1.6	107.12	1.5274	36.00	.3996	143 12	1.9270	1.1777	73.6	
158	" "	1.6	90.80	1.4346	37.60	.4249	128.40	1.8595	1.1102	69.4	
159	" "	1.2	100 55	1.2785	18 00	.2790	118.55	1.5575	0.8082	67 3	67.9
160	" "	1.2	113.89	1.3134	25.30	.3116	139.19	1.6550	0.9057	75.5	
161	" "	1.2	112.91	1.2735	23 90	.3011	136.81	1.5746	0.8253	68.8	
162	" "	1.2	97.00	1.1548	19.10	.3132	116.10	1.4680	0.7187	59.9	
163	" "	0 8	119.58	1.0681	15.40	.2295	134 98	1.2976	0.5483	68.5	72.1
164	" "	0 8	119.70	1 0323	18.15	.2795	137.85	1.3118	0 5625	70.3	
165	" "	0.8	118 30	1.0937	23 70	.2749	142.00	1.3686	0.6193	77.4	
166	Linseed	1 6	99 42	1.4433	8 70	.1357	108.12	1.5790	0 8297	51.9	(60.4)
167	"	1 6	98 65	1.4614	22.60	3480	121.25	1.8094	1.0601	66 2	
168	"	1.6	93.56	1.3722	32.80	.3870	126.36	1.7592	1.0099	63.1	
169	"	1.2	119.55	1.3590	23.00	.2530	142.55	1.6120	0.8627	71.9	68.7
170	"	1.2	83.95	1.1997	33 90	.3661	117.85	1.5658	0.8165	68.0	
171	"	1.2	110 84	1.3073	14.30	.1988	125.14	1.5061	0.7568	63.1	
172	"	1.2	108.13	1.2764	26.40	.3326	134 53	1.6090	0.8597	71.6	
173	"	0.8	96.00	1.0040	25.60	.3123	121.60	1.3163	0.5670	70.8	72.4
174	"	0.8	96 55	0.9733	7 00	.1218	103.55	1.0951	0.3458	43.2*	
175	"	0.8	111.11	1.0150	38.70	.3251	149.81	1.3401	0.5908	73 8	

* Excluded from the average.

TABLE I.—VEGETATION EXPERIMENTS IN SANDY LOAM, 1897.—*Concluded.*

AVAILABILITY OF NITROGEN TO OATS AND HUNGARIAN GRASS.

No. of Pot.	Source of Fertilizer Nitrogen.	Quantities of Fertilizer-Nitrogen (grams).	Oat Crop.		Hungarian Grass Crop.		Total Weights of both Crops, air dry (grams).	Total Weights of Nitrogen in both Crops (grams).	Increase of Crop-Nitrogen over Average Crop-Nitrogen of Pots 5 to 13.	Nitrogen-Increase expressed in Percentages of Fertilizer-Nitrogen. Percentage Availability.	Average Percentage Availability.
			Weights of Crops air dry (grams).	Weights of Nitrogen in Crops (grams).	Weights of Crops air dry (grams).	Weights of Nitrogen in Crops (grams).					
176	Cotton Seed......	1.6	88.02	1.3581	18.20	.2512	106.22	1.6093	.8600	53.8	(59.2
177	" "	1.6	106.88	1.4272	25.60	.3200	132.48	1.7472	.9979	62.4	
178	" "	1.6	95.57	1.4248	23.40	.3089	118.97	1.7337	.9844	61.5	
179	" "	1.2	101.89	1.2115	25.80	.3406	127.69	1.5521	.8028	66.9	65.1
180	" "	1.2	103.15	1.2376	20.30	.2639	123.45	1.5015	.7522	62.7	
181	" "	1.2	81.55	1.2739	31.40	.3266	112.95	1.6005	.8512	70.9	
182	" "	1.2	107.65	1.1819	18.60	.2883	126.25	1.4702	.7209	60.1	
183	" "	0.8	95.05	1.0791	22.15	.2813	117.20	1.3604	.6111	76.4	67.7
184	" "	0.8	101.99	0.9984	5.40	.0988	107.39	1.0972	.3479	43.5*	
185	" "	0.8	104.05	0.9898	14.50	.2320	118.55	1.2218	.4725	59.1	
186	Castor Pomace....	1.6	96.90	1.4184	25.40	.3302	122.30	1.7486	.9993	62.4	(59.9)
187	" "	1.6	103.09	1.4183	14.50	.2335	117.59	1.6518	.9025	56.4	
188	" "	1.6	101.17	1.4462	20.50	.2809	121.67	1.7271	.9778	61.1	
189	" "	1.2	104.60	1.2579	20.40	.2958	125.00	1.5537	.8044	67.0	66.4
190	" "	1.2	102.83	1.2587	15.50	.2650	118.33	1.5237	.7744	64.7	
191	" "	1.2	91.00	1.2743	28.75	.3249	119.76	1.5992	.8499	70.8	
192	" "	1.2	83.39	1.1976	29.40	.3116	112.79	1.5092	.7599	63.3	
193	" "	0.8	85.45	1.0189	18.30	.2818	103.75	1.3007	.5514	68.9	66.0
194	" "	0.8	97.60	1.0358	21.70	.2452	119.30	1.2810	.5317	66.4	
195	" "	0.8	81.50	0.9616	28.00	.2884	109.50	1.2500	.5007	62.5	

* Excluded from the average.

DISCUSSION OF THE RESULTS.

Table I presents a summary of the results of these experiments. The air-dry weights of both the oat and the Hungarian grass crops, and the quantities of nitrogen in each, are given in the table; also the total weights of air-dry crops and of nitrogen contained in the two crops together, roots included.

The figures in the column "Increase of Crop-nitrogen over average Crop-nitrogen of pots 5 to 13" are obtained by subtracting the average amount of nitrogen, 0.7493 gram, which the crops in pots Nos. 5 to 13 contained, from the total amount of nitrogen in the crop of every other pot. This nitrogen-increase, which represents the quantity that the crops took or may have taken from the nitrogenous fertilizer, supplies our best measure of the availability of the nitrogen in the fertilizer.

According to present knowledge various and to some extent contrary changes commonly go on in the soil affecting the nitrogen there present. One, *nitrification*, is the conversion of organic and ammonic nitrogen into nitrates; another, *denitrification*, is the destruction of nitrates with dissipation of nitrogen. We have also the fermentative or putrefactive processes which transform the organic nitrogen into ammonia, and furthermore the conversion of the more active nitrogen of animal and vegetable matter into the inert nitrogen of humus. Nitrification apparently requires a relative abundance of air; denitrification and humification require relative absence of air and abundance of water. These changes appear to be due to different classes of minute organisms which compete with each other in the soil, and of which one or the other gets the upper hand according to conditions of temperature, moisture, etc.

It may thus have happened that a part of the nitrogen increase in the case above cited actually came from the soil and that a part of the added nitric nitrogen was lost.

In the pots 5 to 13 the 0.75 gram of nitrogen taken up by the plants came from the seed or from the nitrogen of the soil. How much in case of the other pots came from these two sources it is impossible to know, but we can only discuss our results by assuming that the nitrogen-increase accompanying the use of fertilizers has been derived from the fertilizers. This we can be sure is largely true.

The figures in the next column, "Nitrogen-increase expressed in Percentages of Fertilizer-nitrogen," show the parts per hundred of the fertilizer-nitrogen which we may assume were taken up by the crop. For example, 1.6 grams of fertilizer-nitrogen in form of nitrate of soda were put into the soil of pot No. 15 and 1.5832 grams of crop-nitrogen were taken from this pot in oats and Hungarian grass together. But pots Nos. 5 to 13, without fertilizer-nitrogen, yielded 0.7493 gram of crop-nitrogen; so that 1.5832, less 0.7493, or 0.7339 gram, is the nitrogen-increase; that part of the crop-nitrogen which came from the nitrate of soda. As 1.6 parts of fertilizer-nitrogen yielded 0.7339 parts of nitrogen-increase, 100 parts of the former would yield 45.8 parts of the latter. So 45.8 is the "percentage availability" of nitrate-nitrogen as calculated from this experiment.

Yield of Crop-Nitrogen from Soil Alone.

The crops from pots Nos. 5 to 13 contain the nitrogen which these crops could gather from the soil alone, to which no fertilizer containing nitrogen had been added.

Since we endeavored to treat all these pots alike, the differences in the weights of crop-nitrogen are the results of accident and of our failure to make all the conditions of growth alike in every pot.

The average quantity of nitrogen taken by the two crops from the soil in nine separate experiments was 0.7493 gram. The largest amount taken was 0.8026 and the smallest 0.6775 gram.

Yield of Crop-Nitrogen from Nitrate of Soda.

Pots 15 to 25 received nitrate of soda as a fertilizer. To pots 15, 16 and 17, 1.6 grams of nitrogen were added; to pots 18, 19, 20 and 21, 1.2 grams of nitrogen, and to pots 23, 24 and 25, 0.8 gram of nitrogen were added in form of nitrate of soda. In the crop from pot 15 the yield of nitrogen was very much smaller than from any other in the series.

Deducting the average quantity of crop-nitrogen found in the series, pots 5 to 13, from the crop-nitrogen in each pot of this nitrate series, there remains the quantity of nitrogen ("nitrogen-increase") which—it is assumed—was taken by the plants from the nitrogen of the fertilizer. These amounts are as follows.—

TABLE II.—NITROGEN-INCREASE FROM NITRATE OF SODA. PERCENTAGE AVAILABILITY.

	From 1.6 grams of fertilizer-nitrogen.		From 1.2 grams of fertilizer-nitrogen.		From 0.8 gram of fertilizer-nitrogen.	
	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.
	0.7339*	45.8	1.0435	86.9	0.8568	107.1
	1.3294	83.1	1.0925	91.0	0.8055	100.6
	1.2159	75.9	1.0715	89.2	0.7975	99.6
			1.0817	90.1		
Average...	1.2736	79.6	1.0723	89.3	0.8199	102.5

Under the conditions of our experiment, the oat crops were able to assimilate all the nitrogen from a dressing of 0.8 gram of nitrogen in form of nitrate of soda, and this application enabled the plants to appropriate slightly more of the soil nitrogen than they could gather without it. From 1.2 grams of fertilizer-nitrogen, the crops took absolutely more nitrogen, but only 89.3 per cent. of the total quantity added.

* Excluded from the average.

From 1.6 grams of fertilizer-nitrogen, the crops took still more nitrogen than from either of the smaller quantities, but the *percentage* of the fertilizer-nitrogen which was recovered in the crop-nitrogen was still smaller, 79.6.

The results indicate :—

1. From the smaller quantity of nitrate the two crops took up all the nitrogen in the fertilizer.
2. From larger quantities than 0.8 gram of nitrate-nitrogen, the two crops could not take up the whole amount, and the larger the quantity of fertilizer-nitrogen applied, the larger the total amount, but the smaller the *proportion* which was taken up.

It follows that where 1.2 or 1.6 grams of fertilizer-nitrogen in form of nitrate were applied, the assimilation of nitrogen by the crops was limited by some other factor than the nitrogen supply, and therefore the results where those quantities of nitrate were used do not show the true availability of nitrate-nitrogen.

Yield of Crop-Nitrogen from Dried Blood.

This series includes pots Nos. 26, 27, and 102 to 109. The crop of Hungarian grass in No. 105 was almost a failure, only three plants surviving. The yields of crop-nitrogen were as follows :—

TABLE III.—NITROGEN-INCREASE FROM DRIED BLOOD. PERCENTAGE AVAILABILITY.

	From 1.6 grams of fertilizer-nitrogen.		From 1.2 grams of fertilizer-nitrogen.		From 0.8 gram of fertilizer-nitrogen.	
	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.	Increase grams.	Percentage availability.
	1.0256	64.1	0.9283	77.4	0.6341	79.3
	1.1318	70.8	0.9024	75.2	0.6077	76.0
	0.9696	60.6	0.6577*	54.8	0.6127	76.6
			0.8013	66.8		
Average...	1.0423	65.1	0.8777	73.1	0.6182	77.3

As in the nitrate of soda series, the percentage increase is largest where the quantity of fertilizer-nitrogen supplied was least, but the differences between the three percentages shown above are much less than in the nitrate series and indicate that with either 0.8 or 1.2 grams of fertilizer-nitrogen *in form of blood*, the assimilation of nitrogen by the crop was limited by the nitrogen supply, rather than by any other factor.

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* Excluded from the average.

It will be noticed that the crop-nitrogen derived from 1.2 grams of blood-nitrogen was not much greater in amount, 0.8777 gram, than the amount of crop-nitrogen from 0.8 gram of nitrate-nitrogen in the fertilizer, 0.8199 gram.

This fact also indicates that 1.2 grams of blood nitrogen were not in excess of the crop requirements.

Yield of Crop-Nitrogen from Dry Ground Fish.

This series includes pots Nos. 110 to 124. The yields of crop-nitrogen were as follows:

TABLE IV.—NITROGEN-INCREASE FROM DRY GROUND FISH. PERCENTAGE AVAILABILITY.

	From 1.6 grams of fertilizer-nitrogen.		From 1.2 grams of fertilizer nitrogen.		From 0.8 gram of fertilizer-nitrogen.	
	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.
	0.9719	60.8	0.8995	75.0	0.5462	68.3
	1.0096	63.1	0.8522	71.0	0.4573	57.2
	0.9123	57.0	0.7590	63.3	0.5226	65.3
			0.7195	60.0		
Average..	0.9646	**60.3**	0.8075	**67.3**	0.5087	**63.6**

In this series also the smallest average percentage increase follows the largest application of fertilizer-nitrogen, though the differences between the averages are not great.

Yield of Crop-Nitrogen from Ground Bone.

This series includes pots Nos. 125 to 142. The quantities of crop-nitrogen were as follows: For the very small yields of crop-nitrogen in pots 125, 127 and 130 we cannot account.

TABLE V.—NITROGEN-INCREASE FROM GROUND BONE AND PERCENTAGE AVAILABILITY.

	From 1.6 grams of fertilizer-nitrogen.		From 1.2 grams of fertilizer-nitrogen.		From 0.8 gram of fertilizer-nitrogen.	
	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.
	0.1916	12.1	0.1950	16.3	0.1132	14.2
	0.3298	20.6	0.2007	16.7	0.1190	13.8
	0.0459	2.9	0.0939*	7.8	0.1637	20.5
			0.2634	21.9		
Average..	----	----	0.2197	**18.3**	0.1289	**16.1**

The results in the first column are too divergent to consider further.

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* Excluded from the average.

Yield of Crop-Nitrogen from Tankage.

This series includes pots Nos. 143 to 155. The yields of crop-nitrogen were as follows:

TABLE VI.—NITROGEN-INCREASE FROM TANKAGE. PERCENTAGE AVAILABILITY.

	From 1.6 grams of fertilizer-nitrogen.		From 1.2 grams of fertilizer-nitrogen.		From 0.8 gram of fertilizer-nitrogen.	
	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.	Increase. gram[illegible]	Percentage availability.
	0.7845	49.0	0.5597	46.6	0.2785*	34.8
	0.8227	51.4	0.6577	54.8	0.4725	59.1
	0.7813	48.8	0.5411	45.1	0.3816	47.7
			0.5863	48.9		
Average..	0.7962	**49.8**	0.5862	**48.8**	0.4270	**53.4**

Yield of Crop-Nitrogen from Horn and Hoof.

This series includes pots Nos. 156 to 165. The yields of crop-nitrogen were as follows:

TABLE VII.—NITROGEN-INCREASE FROM HORN AND HOOF. PERCENTAGE AVAILABILITY.

	From 1.6 grams of fertilizer-nitrogen.		From 1.2 grams of fertilizer-nitrogen.		From 0.8 gram of fertilizer-nitrogen.	
	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.
	1.0129	63.3	0.8082	67.3	0.5483	68.5
	1.1777	73.6	0.9057	75.5	0.5625	70.3
	1.1102	69.4	0.8253	68.8	0.6193	77.4
			0.7187	59.9		
Average..	1.1003	**68.8**	0.8145	**67.9**	0.5767	**72.1**

Yield of Crop-Nitrogen from Linseed Meal.

This series includes pots Nos. 166 to 175. The yields of crop-nitrogen were as follows:

TABLE VIII.—NITROGEN-INCREASE FROM LINSEED MEAL. PERCENTAGE AVAILABILITY.

	From 1.6 grams of fertilizer-nitrogen.		From 1.2 grams of fertilizer-nitrogen.		From 0.8 gram of fertilizer-nitrogen.	
	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.
	0.8297	51.9	0.8627	71.9	0.5670	70.8
	1.0601	66.2	0.8165	68.0	0.3458*	43.2
	1.0099	63.1	0.7568	63.1	0.5908	73.8
			0.8597	71.6		
Average..	.9666	**60.4**	0.8239	**68.7**	0.5789	**72.4**

* Excluded from the average.

Yield of Crop-Nitrogen from Cotton Seed Meal.

This series includes pots Nos. 176 to 185. The yields of crop-nitrogen were as follows:

TABLE IX.—NITROGEN-INCREASE FROM COTTON SEED MEAL. PERCENTAGE AVAILABILITY.

	From 1.6 grams of fertilizer-nitrogen.		From 1.2 grams of fertilizer-nitrogen.		From 0.8 gram of fertilizer-nitrogen.	
	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.
	0.8600	53.8	0.8028	66.9	0.6111	76.4
	0.9979	62.4	0.7522	62.7	0.3479*	43.5
	0.9844	61.5	0.8512	70.9	0.4725	59.1
			0.7209	60.1		
Average..	0.9474	59.2	0.7818	65.1	0.5218	67.7

Yield of Crop-Nitrogen from Castor Pomace.

This series includes pots Nos. 186 to 195. The yields of crop-nitrogen were as follows:

TABLE X.—NITROGEN-INCREASE FROM CASTOR POMACE. PERCENTAGE AVAILABILITY.

	From 1.6 grams of fertilizer-nitrogen.		From 1.2 grams of fertilizer-nitrogen.		From 0.8 grams of fertilizer-nitrogen.	
	Increase grams.	Percentage availability.	Increase grams.	Percentage availability.	Increase grams.	Percentage availability.
	0.9993	62.4	0.8044	67.0	0.5514	68.9
	0.9025	56.4	0.7744	64.7	0.5317	66.4
	0.9778	61.1	0.8499	70.8	0.5007	62.5
			0.7599	63.3		
Average..	0.9599	59.9	0.7971	66.4	0.5279	66.0

SUMMARY.

The figures in Table XI give the percentage availability of fertilizer-nitrogen in the several forms, as determined in our tests of 1897†—just described—and also as determined in experiments made in the three years 1894, 1895 and 1896, in a soil composed of coal ashes and peat. In the tests of 1897 a considerable portion of the root system was included in the crop, in the others *none* of the roots were thus included.

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* Excluded from the average.

† The quantity of available nitrogen which the crop can freely take, without limitation by other conditions than nitrogen-supply, lies somewhere between 0.8 and 1.2 grams, as appears from the discussion of the results in the nitrate series. Examination of all the experiments leads us to conclude that this limit is not far from 0.9 gram. Therefore when the fertilizer-nitrogen taken up by the crops exceeded 0.9 gram the corresponding percentage availability is enclosed in brackets and the average in the table excludes the figures so enclosed.

It appears that in every case a much larger percentage of the fertilizer-nitrogen was taken by the crops in the experiments of 1897, natural soil, than in the previous cultures made in coal ashes and peat. Part of this increase is due to the inclusion of roots with the crops in 1897.

TABLE XI.—PERCENTAGE AVAILABILITY OF FERTILIZER-NITROGEN.

	EXPERIMENTS OF 1897.				Experiments of 1894, 1895 and 1896.		Nitrogen-availability reckoned on nitrate.
Quantity of Fertilizer-nitrogen, grams.	1.6	1.2	0.8	Average.	Average.	Difference.	1897.
Nitrate of soda	(79.6)	(89.3)	102.5	102.5	64	38	100
Dried blood	(65.1)	73.1	77.3	75.2	43	28	73.3
Dry ground fish	(60.3)	67.3	63.6	65.5	44	34	63.9
Ground bone	----	18.3	16.1	17.2	--	--	16.7
Tankage	49 8	48.8	53.4	50.7	38	19	49.4
Horn and hoof	(68.8)	67.9	72.1	70.0	42	20	68.3
Linseed meal	(60.4)	68.7	72.4	70.6	45	22	68.9
Cotton seed meal	(59.2)	65.1	67.7	66.4	46	13	64.8
Castor pomace	(59.9)	66.4	66.0	66.2	47	26	64.6

The percentage availability of nitrogen to the oat crop of 1897 would have been made less by about 12 per cent. on the average, if the roots had been excluded.

If we may assume that a like percentage added to the percentage availability as determined in the experiments of 1894, 1895 and 1896 will correctly compensate for the exclusion of the roots in those experiments, it still appears that on the average a larger percentage of nitrogen was assimilated in the experiments of 1897 than in the earlier ones. This is particularly noticeable in the case of nitrate and of dried blood.

The last column of Table XI gives the comparative nitrogen availability reckoned on nitrate as 100.

The figures show

1. In these experiments of 1897, the nitrogen of raw knuckle bone, ground to pass a sieve with circular holes $\frac{1}{50}$ of an inch in diameter, had only one-sixth of the availability of the nitrogen of nitrate, one-quarter of that of linseed, cotton seed, castor pomace, steamed horn and hoof and fish, and about one-third of that of tankage. The bone used was very dense and hard, unlike most of the ground bone which is sold in our market as a fertilizer, and presumably less readily available. The subject is further discussed in the following paper.

2. In these experiments of 1897, the nitrogen of tankage (which contains considerable bone, "bone tankage,") had an availability, compared with that of nitrate-nitrogen, of 49 per cent. while the nitrogen of cotton seed, linseed and castor pomace, as well as that of horn and hoof and in fish, had an availability of from 64 to 69 per cent.

3. The experiments of 1897 show but little difference in the availability of nitrogen in cotton seed, linseed, castor pomace, horn and hoof, and fish. In this year the nitrogen of blood had a higher availability than that of the materials just named.

II. Cultures of Hungarian Grass in a Natural Soil.

Pots 198 to 245.

In the following series of experiments, nitrate of soda, cotton-seed meal and bone in three different grades of fineness are compared with reference to the availability of the nitrogen in them.

The apparatus and method, kind and amount of soil, method of mixing and filling, watering, and care during growth were precisely alike in this series and in the one just described on pages 257 to 271. With the soil of each pot were carefully mixed 50 grams of precipitated calcium carbonate and 5 grams of potassium phosphate, containing 0.1971 gram of phosphoric acid and 0.2629 gram of potash.

To the soil of each pot was also added the quantity of nitrogen given in Table XII.

The nitrogenous matters used were nitrate of soda and cotton-seed meal, a part of the stock described on page 258, and in addition, a raw knuckle bone, free from adhering tendon and grease, in three grades of fineness.

These grades were as follows:—

Description of Grades of Bone used in the Experiment.

Grade.
A, passes bolting cloth, holes $\frac{1}{150}$ in. diameter,* contains 3.58 per cent. of nitrogen
B, " circular holes between $\frac{1}{50}$ and $\frac{1}{150}$ in. diam. " 3.88 " "
C. " " " " $\frac{1}{25}$ and $\frac{1}{50}$ " " 4.08 " "

The pots were filled on June 14th and 16th.

Fifteen selected seeds of Hungarian grass were planted in the pots of this series on June 23d without previous germination. On June 26th the first germinated plants appeared and on June 28th plants had appeared in all the pots. On July 8th and 9th the

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* The mesh is 0.16^{mm} wide in the clear. The holes are not circular, but rather octagonal in outline.

TABLE XII.—AVAILABILITY OF NITROGEN IN NITRATE, COTTON-SEED MEAL AND BONE OF DIFFERENT GRADES OF FINENESS.

CULTURES OF HUNGARIAN GRASS, 1897.

No. of Pot.	Source of Fertilizer-Nitrogen.	Quantities of Fertilizer-Nitrogen. Grams	Weights of Air-dry Crops, Percentages of Nitrogen and Total Nitrogen in the Crops.											Increase of Crop-Nitrogen over Crop-Nitrogen in Crops Nos. 198, 199 and 200.	Nitrogen-Increase expressed in Percentages of Fertilizer-Nitrogen.
			Roots.			Stalks and Leaves.			Seed.			Total.			
			Air-dry weight. Grams.	Per cent. Nitrogen.	Total Nitrogen. Grams.	Air-dry weight. Grams.	Per cent. Nitrogen.	Total Nitrogen. Grams.	Air-dry weight. Grams.	Per cent. Nitrogen.	Total Nitrogen. Grams.	Air-dry weight. Grams.	Nitrogen. Grams.		
198	No Nitrogen added	....	24.9	.40	.0996	43.2	.32	.1382	24.3	1.56	.3791	92.40	.6169	....	....
199		....	20.6	.50	.1030	38.9	.32	.1245	23.6	1.60	.3776	83.10	.6051	....	....
200		....	14.5	.53	.0769	41.7	.34	.1418	23.7	1.54	.3650	79.90	.5837	....	....
201	Nitrate of Soda	1.6	44.1	.50	.2205	50.3	0.98	.4929	55.4	2.21	1.2243	149.80	1.9377	1.3358	83.5
202		1.6	25.8	.74	.1909	34.6	1.26	.4360	41.3	2.34	0.9664	101.70	1.5933	0.9914	61.9
203		1.6	26.5	.86	.2279	38.2	1.24	.4737	49.4	2.34	1.1560	114.10	1.8576	1.2557	78.5
204		1.2	27.3	.64	.1747	41.9	1.04	.4358	48.1	2.31	1.1111	117.30	1.7216	1.1197	93.3
205		1.2	53.0	.53	.2809	46.7	0.85	.3970	56.2	2.17	1.2195	155.90	1.8974	1.2955	108.0
206		1.3	31.6	.63	.1991	33.1	1.32	.4369	41.4	2 36	0.9770	106.10	1.6130	1.0111	84.3
207		0.8	39.0	.50	.1950	49.3	0.45	.2219	46.5	1.95	0.9068	134.80	1.3237	0.7218	90.2
208		0.8	31.3	.46	.1440	62.5	0.69	.4313	35.3	2.08	0.7342	129.10	1.3095	0.7076	88.5
209		0.8	28.0	.62	.1736	46.6	0.59	.2749	48.9	2.06	1.0073	123.50	1.4558	0.8539	106.8
210	Cotton-Seed Meal	1.6	38.3	.58	.2221	53.1	.67	.3558	45.3	2.12	0.9604	136.70	1.5383	.9364	58.5
211		1.6	34.8	.58	.2018	52.2	.54	.2819	49.5	2.10	1.0395	136.50	1.5232	.9213	57.6
212		1.6	27.8	.52	.1446	48.6	.58	.2819	51.2	2.07	1.0598	127.60	1.4863	.8844	55.3
213		1.2	29.4	.56	.1646	53.3	.50	.2665	42.6	1.89	0.8051	125.30	1.2362	.6343	52.9
214		1.2	29.6	.55	.1628	54.3	.43	.2335	41.4	1.93	0.7990	125.30	1.1953	.5934	49.5
215		1.2	40.9	.50	.2045	53.4	.42	.2243	46.9	1.84	0.8630	141.20	1.2918	.6899	57.5
216		0.8	34.1	.48	.1637	39.5	.47	.1857	41.4	1.76	0.7286	115.00	1.0780	.4761	59.5
217		0.8	28.9	.47	.1358	44.2	.38	.1680	38.8	1.78	0.6906	111.90	0.9944	.3925	49.1
218		0.8	36.3	.46	.1670	56.8	.36	.2045	38.2	1.74	0.6647	131.30	1.0362	.4343	54.3
219	Bone, Grade A. Passed holes $\frac{1}{150}$	1.6	28.8	.44	.1267	46.4	.33	.1531	32.5	1.60	.5200	107.70	.7998	.1979	12.4
220	inch diameter	1.6	30.9	.43	.1329	44.0	.35	.1540	27.8	1.62	.4504	102.70	.7373	.1354	8.5
221		1.6	27.6	.46	.1270	48.4	.37	.1791	28.9	1.62	.4682	104.90	.7743	.1724	10.8
222		1.2	29.3	.46	.1348	46.0	.34	.1564	29.1	1.64	.4772	104.40	.7684	.1665	13.9

TABLE XII.—AVAILABILITY OF NITROGEN IN NITRATE, COTTON-SEED MEAL AND BONE OF DIFFERENT DEGREES OF FINENESS.—*Continued.*

No. of Pot.	Source of Fertilizer-Nitrogen.	Quantities of Fertilizer-Nitrogen. Grams.	Weights of Air-dry Crops, Percentages of Nitrogen and Total Nitrogen in the Crops.											Increase of Crop-Nitrogen over Crop-Nitrogen in Crops Nos. 198, 199 and 200.	Nitrogen-Increase expressed in Percentages of Fertilizer-Nitrogen.
			Roots.			Stalks and Leaves.			Seed.			Total.			
			Air-dry weight. Grams.	Per cent. Nitrogen.	Total Nitrogen. Grams.	Air-dry weight. Grams.	Per cent. Nitrogen.	Total Nitrogen. Grams.	Air-dry weight. Grams.	Per cent. Nitrogen.	Total Nitrogen. Grams.	Air-dry weight. Grams.	Nitrogen. Grams.		
223	Bone, Grade A. Passed holes $\frac{1}{150}$ inch diameter	1.2	19.7	.51	.1005	42.7	.45	.1922	29.2	1.58	.4614	91.60	.7541	.1522	12.7
224		1.2	19.3	.50	.0965	43.5	.38	.1653	28.0	1.62	.4536	90.80	.7154	.1135	9.5
225		0.8	16.4	.59	.0968	42.0	.37	.1554	26.3	1.64	.4313	84.70	.6835	.0816	10.2
226		0.8	19.8	.53	.1049	47.5	.34	.1615	27.5	1.52	.4180	94.80	.6844	.0825	10.3
227		0.8	27.5	.42	.1155	44.8	.32	.1434	26.0	1.60	.4160	98.30	.6749	.0730	9.1
228	Bone, Grade B. Passed circular holes between $\frac{1}{50}$ and $\frac{1}{150}$ inch diameter	1.6	17.5	.46	.0805	40.2	.33	.1327	31.8	1.56	.4961	89.50	.7093	.1074	6.7
229		1.6	26.3	.44	.1157	49.6	.35	.1736	28.7	1.52	.4362	104.60	.7255	.1236	7.7
230		1.6	29.3	.41	.1201	37.1	.39	.1447	28.3	1.56	.4415	94.70	.7063	.1044	6.5
231		1.2	21.6	.47	.1015	43.3	.34	.1472	27.1	1.56	.4228	92.00	.6715	.0696	5.8
232		1.2	22.6	.47	.1062	50.5	.37	.1869	22.9	1.68	.3847	96.00	.6778	.0759	6.3
233		1.2	18.5	.56	.1036	42.0	.41	.1722	25.0	1.71	.4275	85.50	.7033	.1014	8.5
234		0.8	25.2	.50	.1260	43.3	.31	.1342	27.8	1.60	.4448	96.30	.7050	.1031	12.6
235		0.8	19.8	.54	.1069	50.6	.29	.1467	25.9	1.62	.4196	96.30	.6732	.0713	8.9
236		0.8	29.5	.43	.1269	34.1	.35	.1194	24.7	1.74	.4298	88.30	.6761	.0742	9.3
237	Bone, Grade C. Passed circular holes between $\frac{1}{25}$ and $\frac{1}{50}$ inch diameter	1.6	20.8	.53	.1102	41.9	.37	.1550	26.4	1.64	.4330	89.10	.6982	.0963	6.0
238		1.6	14.8	.54	.0799	42.5	.36	.1530	25.7	1.53	.3932	83.00	.6261	.0242	1.5
239		1.6	22.2	.46	.1021	41.3	.38	.1569	24.2	1.69	.4090	87.70	.6680	.0661	4.1
240		1.2	24.6	.41	.1009	42.2	.37	.1561	26.8	1.56	.4181	93.60	.6751	.0732	6.1
241		1.2	20.9	.50	.1045	39.9	.36	.1436	25.2	1.60	.4032	86.00	.6513	.0494	4.1
242		1.2	23.1	.50	.1155	41.0	.37	.1517	28.5	1.53	.4361	92.60	.7033	.1014	8.5
243		0.8	18.0	.50	.0900	38.8	.35	.1358	25.6	1.54	.3942	82.40	.6200	.0181	2.3
244		0.8	29.8	.38	.1132	48.6	.33	.1604	26.6	1.53	.4070	105.00	.6806	.0787	9.8
245		0.8	21.4	.49	.1049	44.5	.31	.1380	25.7	1.57	.4035	91.60	.6464	.0445	5.6

soil in each pot was mulched with filter paper covered with coarse moss peat. On July 13th the crops in all the pots were fairly uniform in color and size, being about one foot in height, and beginning to tiller.

The crops were harvested on September 21st. Each was divided into three parts: the seed heads with ripe seed, the stalks with leaves and the roots.

The air-dry weight and the percentage of nitrogen were determined in each of these parts. The results are given in Table XII.

Discussion of the Results.

To the soil of pots 198, 199 and 200 no nitrogenous fertilizer was supplied. The crops in those pots contained 0.6169, 0.6051 and 0.5837 gram of nitrogen respectively (an average of 0.6019 gram), which they gathered from the soil itself. It may be noted that under like conditions of soil, the oat crop of the series of experiments described on pp. 257 to 271, which was in the pots for 87 days (May 10th to Aug. 6th), took 0.5065 gram of nitrogen from the soil to which no nitrogenous fertilizer had been added; while Hungarian grass, which was in the pots for 89 days (June 23d to Sept. 21st), took 0.6019 gram.

This average weight, subtracted from the total weight of nitrogen harvested in each of the other crops, given the nitrogen-increase attributable to the fertilizer shown in the last column but one of Table XII.

From these figures may be calculated the percentage quantities of nitrogen taken up by the crops from the several nitrogenous fertilizers, and these are given in the last column of the table.

Yield of Crop-Nitrogen from Nitrate of Soda.

Pots 201 to 203 received 1.6 grams, pots 204 to 206, 1.2 grams, and pots 207 to 209, 0.8 gram of nitrate-nitrogen.

Subtracting the average quantity of crop-nitrogen found in the crops of pots 198, 199 and 200, 0.6169 gram, from the nitrogen harvested in pots 201 to 209, there remains the quantity of fertilizer-nitrogen presumably taken by the plants from the nitrate. These amounts are as follows:

TABLE XIII.—NITROGEN INCREASE FROM NITRATE OF SODA. PERCENTAGE AVAILABILITY.

	From 1.6 grams of fertilizer-nitrogen.		From 1.2 grams of fertilizer-nitrogen.		From 0.8 gram of fertilizer-nitrogen.	
	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.
	1.3358	83.5	1.1197	93.3	.7218	90.2
	.9914	61.9	1.2955	108.0	.7076	88.5
	1.2557	78.5	1.0111	84.3	.8539	106.8
Average..	1.1943	74.6	1.1421	95.3	.7611	95.2

One result in each of the three series is widely different from the other two. These differences were not suspected at harvest and cannot be explained. It is clear, however, that from the largest application of nitrate-nitrogen, the crop was not able to take as large a *percentage* of the nitrogen as from the smaller applications. This indicates that where the largest amount of fertilizer-nitrogen was used, some factor of crop-production other than nitrogen supply ruled and therefore the crop nitrogen in this case is not a measure of nitrogen-availability.

Yield of Crop-Nitrogen from Cotton Seed Meal.

To the soil of pots 210 to 218 was added cotton seed meal. If from the total nitrogen of each crop is subtracted that which the crop was able to get from the soil alone, the following figures are obtained :

TABLE XIV.—NITROGEN INCREASE FROM COTTON SEED MEAL. PERCENTAGE AVAILABILITY.

	From 1.6 grams of fertilizer-nitrogen.		From 1.2 grams of fertilizer-nitrogen.		From 0.8 gram of fertilizer-nitrogen.	
	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.
	.9364	58.5	.6343	52.9	.4761	59.5
	.9213	57.6	.5934	49.5	.3925	49.1
	.8844	55.3	.6899	57.5	.4343	54.3
Average..	.9140	58.1	.6392	53.3	.4343	54.3

The results in this series are fairly accordant and indicate that on the average 55.2 per cent. of the cotton seed nitrogen was taken by the crops.

Yield of Crop-Nitrogen from Bone, Grade A (which passed bolting cloth, holes $\frac{1}{150}$ in. diameter).

The quantity of nitrogen which the crops were able to get from the soil alone, 0.6019 gram, subtracted from the total nitrogen of the crops in pots 219 to 227, gives the following figures :

TABLE XV.—NITROGEN INCREASE FROM GROUND BONE, GRADE A. PERCENTAGE AVAILABILITY.

	From 1.6 grams of fertilizer-nitrogen.		From 1.2 grams of fertilizer-nitrogen.		From 0.8 gram of fertilizer-nitrogen.	
	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.
	.1979	12.4	.1665	13.9	.0816	10.2
	.1354	8.5	.1522	12.7	.0825	10.3
	.1724	10.8	.1135	9.5	.0730	9.1
Average..	.1686	10.5	.1441	12.0	.0790	9.9

It appears that on the average 10.8 per cent. of the nitrogen of this grade of bone was taken by the crops.

Yield of Crop-Nitrogen from Bone, Grade B, (passed holes between $\frac{1}{50}$ and $\frac{1}{150}$ in. diameter).

The quantity of nitrogen which the crops were able to get from the soil alone, 0.6019 gram, subtracted from the total nitrogen of the crops in pots 228 to 236, gives the following figures:

TABLE XVI.—NITROGEN INCREASE FROM GROUND BONE, GRADE B. PERCENTAGE AVAILABILITY.

	From 1.6 grams of fertilizer-nitrogen.		From 1.2 grams of fertilizer-nitrogen.		From 0.8 gram of fertilizer-nitrogen.	
	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability
	.1074	6.7	.0696	5.8	.1031	12.6
	.1236	7.7	.0759	6.3	.0713	8.9
	.1044	6.5	.1014	8.5	.0742	9.3
Average..	.1118	7.0	.0823	6.9	.0829	10.4

The average percentage of fertilizer-nitrogen taken by the crops was 8.1.

Yield of Crop-Nitrogen from Bone, Grade C, (passed holes between $\frac{1}{25}$ and $\frac{1}{50}$ in. diameter).

The quantity of nitrogen which the crops were able to get from the soil alone, 0.6019 gram, subtracted from the total nitrogen of the crops in pots 237 to 245, gives the following figures :

TABLE XVII —NITROGEN INCREASE FROM GROUND BONE, GRADE C. PERCENTAGE AVAILABILITY.

	From 1.6 grams of fertilizer-nitrogen.		From 1.2 grams of fertilizer-nitrogen.		From 0.8 gram of fertilizer-nitrogen.	
	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.	Increase. grams.	Percentage availability.
	.0963	6.0	.0732	6.1	.0181	2.3
	.0242	1.5	.0494	4.1	.0787	9.8
	.0661	4.1	.1014	8.5	.0445	5.6
Average..	.0622	3.9	.0747	6.2	.0471	5.9

The average percentage of fertilizer-nitrogen taken by the crops was 5.3.

The figures in the following table give the fertilizer-nitrogen taken up by the crops expressed in percentages of the total fertilizer-nitrogen, or the percentage availability of the fertilizer-nitrogen.

TABLE XVIII.—PERCENTAGE AVAILABILITY OF FERTILIZER-NITROGEN.

Quantity of fertilizer-nitrogen, grams.	1.6	1.2	0.8	Average.	Nitrogen availability reckoned on nitrate.
Nitrate of Soda	74.6*	95.3	95.2	95.3	100.0
Cotton Seed Meal	58.1	53.3	54.3	55.2	57.9
Bone, Grade A	10.5	12.0	9.9	10.8	11.3
Bone, Grade B	7.0	6.9	10.4	8.1	8.5
Bone, Grade C	3.9	6.2	5.9	5.3	5.6

It thus appears that in these cultures, while 95.3 per cent. of the nitrogen of nitrate of soda and 57.9 per cent. of that of cotton seed meal were taken up by the crop, under similar conditions, only 11.3 per cent. of the nitrogen of the finest bone flour was taken by the crops and still less than that percentage from coarser grades.

These figures do not indicate that the nitrogen of bone is always or generally inferior to that of other animal and vegetable materials.

Bone finds its most profitable use on crops like grass and clover which are not annuals, but whose roots occupy the soil through the whole year and are more or less active at all seasons.

The best grass lands too are loams inclined to be heavy or clayey rather than sandy and, in consequence, retentive of moisture. On such soils it is very likely that bone decomposes more rapidly than in the sandy loam of our experiment and the perennial roots of the crops named would certainly be more efficient in taking up the nitrogen of fertilizers, than those of the short-lived plants (oats and Hungarian grass) used in our experiments. It should also be noted that the bone used by us was of the hardest kind, such as is used for the manufacture of "ivory" goods, which is presumably more slowly decomposed and dissolved in the soil than other sorts.

III. CULTURES OF RYE AND OATS FOLLOWED BY HUNGARIAN GRASS.

POTS NOS. 277 TO 298.

In these cultures nitrate of soda, cotton seed meal and raw knuckle bone, in five different degrees of fineness, have been compared as regards the availability of their nitrogen. The results obtained in 1896 have been described in the 20th Report of this Station for 1896, pp. 197–204.

The very exceptional rainfall in the summer of 1897 greatly damaged the experimental crops and the results are withheld from publication till supplemented by those of another year.

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* Excluded from the average.

ON THE USE OF COMMERCIAL FERTILIZERS FOR FORCING HOUSE CROPS.

By E. H. Jenkins and W. E. Britton.*

I. EXPERIMENTS WITH TOMATOES. SEASON OF 1896-1897.

This work is a continuation of that begun during the winter of 1894-1895, the results of which have been published in the Reports of this Station for 1895, pp. 75 to 98, and for 1896, pp. 205 to 221.

The cultures here to be described were made chiefly to test the effect of still larger quantities of fertilizer chemicals than were used in the previous years, to determine whether or not the addition of moss peat to the bituminous ashes used as a culture medium was advantageous, and to further compare the crops grown on rich compost with those grown on ashes and moss peat.

Houses, Benches and Plots.

The plots used are numbered 150 to 173, houses D and E, in the Plan of Forcing Houses given on page 309. Each plot has an area of 13.87 square feet.

Soils and Fertilizers.

Three kinds of soil were used. One was a compost, such as is commonly used in forcing houses, consisting of thick turf, mixed with one-third its bulk of stable manure, and well worked over during the preceding summer.

Another soil consisted, for each plot, of 300 pounds of bituminous coal ashes from the Lake Whitney Pumping Station, sifted through a screen with four meshes to the linear inch.

The third soil was a mixture of 300 pounds of the ashes just described, with 9 pounds of moss peat, sifted through the same screen as the ashes. This moss peat is sold in cities for stable bedding.

To the soils consisting of ashes and of ashes and peat, commercial fertilizers were added in carefully determined amounts and were very thoroughly mixed by repeated shovelling over.

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* The general plan of this study, the arrangement of its details and the preparation of this paper are our joint work. The horticultural work has been done wholly by Mr. Britton. All the chemical work involved has been done by Messrs. Winton, Ogden and Mitchell.

The First Crop. September, 1896 *to February*, 1897.

Plants. Seeds of the Lorillard variety were sown in flats July 24th. The seedlings were put in 2½ inch pots about the middle of August, shifted to 4-inch pots on August 24th and set in the benches Sept. 23d, without removing the earth about their roots. Six plants were set in each plot. The plants were trimmed to a single stem. All lateral shoots were removed, dried and preserved for analysis—those from each plot by themselves.

Notes regarding Growth. The plants, when set in the benches, were slightly affected by a fungus (*Cladosporium fulvum*). This disease increased and was not checked appreciably by spraying with ammoniacal copper carbonate on Sept. 24th and 27th. Even dipping the leaves into the solution, on Oct. 2, while more effectual, did not completely destroy the fungus. On Oct. 8 the lower leaves of all the plants were dipped in Bordeaux mixture. This proved effectual, and by the 28th the fungus had wholly disappeared, having done no serious harm since Bordeaux mixture was first applied.

Artificial heat was used day and night after Oct. 9 and this was no doubt helpful in controlling the fungus, *Cladosporium*, which is always more troublesome in autumn and spring, when the temperature of the house goes quite low at night.

The first pollinating was done on Sept. 30th, and daily thereafter for a time, and then every second day as long as the plants blossomed.

Late in October the plants in those plots which had received the largest amounts of fertilizer chemicals, 157, 163, 165, and 166, were noticeably smaller than the others, and the plants growing in compost to which chemicals had been applied were also smaller than those to which no chemicals were added.

About the middle of November the plants growing in compost alone were the largest in the house. Where fertilizer chemicals had been added to the compost, the foliage was a darker green, but both plants and fruit were smaller.

At this time the plants in plots 165 and 166 were the smallest in the house, and those growing in ashes were smaller than those growing in the corresponding plots of ashes and peat.

A very slight attack of the "burn" or "scald," described in the Report for 1896, p. 232, appeared in the part of the house where it was most troublesome last year, and later, elsewhere in the house, but practically no damage was done by it.

Late in December, the leaves of all the plants growing in the soil of coal ashes alone (without moss peat) turned yellow, except at the growing tip of the plant, while those in corresponding plots of coal ashes and peat had a good green color.

Gradually the lower leaves of all the plants growing in the mixture of ashes and moss peat ripened and turned yellow, as if the supply of plant food in the soil were nearly exhausted.

The plants on plot 165, which received more nitrogen and potash than any other, were the last to turn.

On Dec. 30, 133 grams of nitrate of soda, 35 grams of dissolved boneblack and 73 grams of muriate of potash were dissolved in water and a portion added to this plot. More was added every few days, the last being applied Jan. 20th. After each application the plot was well watered. This treatment prevented further yellowing of the foliage and the new growth was of normal color. The yield of fruit, however, was not much larger.

Harvesting. Complete record was kept of the number and weight of fruits from each plot, with the dates of picking. The first fruit (premature and decaying) was picked Nov. 28 from plot 170. On Dec. 3d perfect fruit was picked from several plots and the crop was fast ripening.

On Feb. 16th the vines together with the small green fruit still on them, and the roots, were gathered, dried, and with the trimmings made during the season, were weighed and analyzed to determine the quantities of nitrogen, phosphoric acid and potash in them. Average samples of the fruit, gathered during the season, were also analyzed for the same purpose. The results of these analyses appear in following tables.

The Second Crop. February to July, 1897.

Before setting the plants, there were added to the ashes in each of the plots, 158 to 165 inclusive, 25 pounds of meadow peat from Beaver Swamp and 12.5 grams of precipitated calcium carbonate, to neutralize the acidity of the peat.

Certain changes were also made in the quantity of fertilizers which were added, as will appear in the following tables.

Plants. Seeds of the Lorillard variety were sown Dec. 24th. On Jan. 7th the seedlings were put in 2½ inch pots, shifted to 4 inch pots Feb. 1st, but owing to unavoidable delays in the chemical examination of the previous crops the plants could not be set in the benches till March 10th. They soon started into vigorous growth but did not at first blossom freely.

About the 15th of April the plants next the forcing house wall in plot 153 became yellow and much less thrifty than the others in the plot and yielded little fruit, while the others in the same plot yielded well. The cause of this trouble was not apparent.

Artificial heating of the houses was discontinued from April 15th. Soon after, some of the smaller, green tomatoes began to decay at the blossom end. This disease, usually attributed to the fungus, *Macrosporium tomato*, and which also appeared last year (Report for 1896, p. 208), prevailed until the first of June and considerably diminished the yield of fruit.

The largest per cent. of decayed fruit was from plot 172, filled with compost, which had received no fertilizers after the first crop had been harvested.

The plant-house Aleyrodes was rather troublesome, making it necessary to fumigate every week; the mealy bug (*Dactylopius adonidum*) also appeared, and was combatted by applications of fir tree oil; and near harvest time, a fungus (*Cladosporium fulvum*) seriously attacked the plants.

Blossoms were hand-pollinated in the same way as for the first crop.

Harvesting. The first tomatoes were picked May 1 from plot 157. The fruits were generally smooth and of good size. The final picking was on July 19, and then the plants with their roots were gathered, as already described in the notes of the first crop.

DISCUSSION OF THE RESULTS.

A. *The First Crop.*

Tables I, II and III show the soils used, the fertilizers applied, and the crop taken from each plot.

Compost alone, and with added fertilizer chemicals.

Table III shows the crops from six plots filled with compost. To three of them fertilizer chemicals were also added. The three to which no chemicals were added yielded an average of 7759 grams of fruit or 1.23 pounds of fruit per foot of bench space. The three to which chemicals were applied yielded an average of 6838 grams of fruit or 1.08 pounds per square foot. The highest

TABLE I.—TOMATO CULTURES IN BITUMINOUS COAL ASHES AND MOSS PEAT. SEPT. 1896 TO FEB. 1897.

Fertilizers.	Plot 150.	Plot 151.	Plot 152.	Plot 153.	Plot 154.	Plot 155.	Plot 156.	Plot 157	Plot 166.
Nitrate of Soda, grams	390.5	390.5	390.5	390.5	461.5	461.5	532.5	532.5	532.5
Cotton Seed Meal, "									457
Nitrogen, "	55	55	55	55	65	65	75	75	109
Dissolved Bone Black, "	141.36	141.36	141.36	141.36	141.36	141.36	141.36	141.36	141.36
Phosphoric Acid, "	24	24	24	24	24	24	24	24	24
Muriate of Potash, "	129	161.75	215	290.25	161.75	290.25	161.75	290.25	290.25
Potash, "	60	75	100	135	75	135	75	135	135
Yield.									
Total yield of fruits, fresh weight, grams	8914	8399	8011	6623	12575	10879	9210	9963	9467
" " vines, air dry, "	342	344.7	349 1	259.6	447.1	365.3	358.0	369.2	423.4
" " roots, " "	19.9	25.4	26 0	21.6	33.2	28.0	25.1	25.5	23 2
Average yield of fruits per plant, grams	1486	1400	1169	1104	2096	1813	1535	1666	1578
" " " " pounds	3.2	3.08	2.6	2.4	4.6	4.0	3.4	3.7	3.5
" number of fruits per plant	19	19.5	17.6	16 5	19.6	21.6	20.3	22.8	22.1
" weight of ripe fruits, grams	79	76	77	69	99	87	83	88	76
Per cent. of perfect-shaped fruits	36	44.4	50	72.7	50.8	69	59	55.4	85.8
Average yield of fruits per square foot of bench area, grams	642	606	578	478	907	784	664	720	683
Average yield of fruits per square foot of bench area, pounds	1.4	1.3	1.2	1.05	2	1.7	1.4	1.6	1.5

TABLE II.—TOMATO CULTURES IN BITUMINOUS COAL ASHES (WITHOUT PEAT). SEPT. 1896 TO FEB. 1897.

Fertilizers.	Plot 158.	Plot 159.	Plot 160.	Plot 161.	Plot 162.	Plot 163.	Plot 164.	Plot 165.*
Nitrate of Soda, grams	390.5	390.5	390.5	390.5	461.5	461.5	532.5	532.5
Nitrogen, "	55	55	55	55	65	65	75	75
Dissolved Bone Black, "	141.36	141.36	141.36	141.36	141.36	141.36	141.36	141.36
Phosphoric Acid, "	24	24	24	24	24	24	24	24
Muriate of Potash, "	129	161.75	215	290.25	161.75	290.25	161.75	290.25
Potash, "	60	75	100	135	75	135	75	135
Yield.								
Total yield of fruits, fresh weight, grams	5008	6140	4447	4608	6104	5172	7385	6673
" " " vines, air dry, "	289.3	285.7	237.7	270	300.6	286	300.3	407 4
" " " roots, " " "	20.5	21.3	21.2	20.6	28.2	23.3	24.1	21
Average yield of fruits, per plant, grams	835	1023	741	768	1017	862	1231	1112
" " " " " " pounds	1.8	2 2	1.6	1.7	2.2	1.9	2.7	2.4
Average number of fruits, per plant	12.8	14.5	10.8	11.6	14.3	13.	17.6	16.8
Average weight of ripe fruits, grams	68	78	75	74	82	74	76	67
Per cent. of perfect-shaped fruits	51.9	50.5	55.3	54.2	54.6	44.8	51.7	56.4
Average yield of fruits per square foot of bench area, grams	361	443	321	332	440	373	532	481
Average yield of fruits per square foot of bench area, pounds	.79	.98	.71	.74	.97	.82	1.17	1.06

* During January, Plot 165 received, in addition to the fertilizers named in the table, 133 grams nitrate of soda, 35 grams of dissolved bone black and 73 grams of muriate of potash. See page 280.

yield was less than the average yield of the three plots without chemicals. In no case was there a decidedly larger yield resulting from the addition of commercial fertilizers to rich compost, but on the other hand the average yield has been rather less where they were added. In the latter case, also, the average weight per fruit was smaller, though the per cent. of perfect-shaped fruit was somewhat larger.

TABLE III. TOMATO CULTURES IN COMPOST. SEPT. 1896 TO FEB. 1897.

Fertilizers.	Plot 167.	Plot 168.	Plot 169.	Plot 170.	Plot 171.	Plot 172.
Nitrate of Soda, grams	60.35	none	120.70	none	241.40	none
Nitrogen, "	8.5		17.		34.	
Dissolved Bone Black, "	23.56	none	47.12	none	94.24	none
Phosphoric Acid "	4.		8.		16.	
Muriate of Potash "	45.15	none	90.30	none	180.60	none
Potash "	21.		42.		84.	

Yield.	Plot 167.	Plot 168.	Plot 169.	Plot 170.	Plot 171.	Plot 172.
Total yield of fruits, fresh weight, grams	7347	7455	7582	7774	5585	8049
Total yield of vines, air dry, grams,	376	374.8	400.5	390.3	347.3	412
" " " roots " " "	26.2	29.4	26.4	33.4	23.2	35
Average yield of fruits per plant, grams	1225	1246	1264	1296	931	1382
Average yield of fruits per plant, pounds	2.7	2.7	2.8	2.9	2	3
Average number of fruits per plant,	22.6	21.6	21.1	20.3	16.6	20.5
Average weight of ripe fruits, grams,	59	65	62	68	60	71
Per cent. of perfect-shaped fruits	50.7	40	56	48.6	60	56.8
Average yield of fruits per square foot of bench area, grams	529	537	548	560	403	580
Average yield of fruits per square foot of bench area, pounds	1.16	1.18	1.21	1.23	0.88	1.28

Compost compared with Mixtures of Coal Ashes, Moss Peat and Chemicals.

Table III gives the yields from six cultures in compost. To three of these, fertilizer chemicals were added which, however, rather depressed the yield.

The three largest yields, plots 169, 170 and 172, were 7582, 7774 and 8049 grams of fruit per plot, the average being 7802 grams or 1.24 pounds of fruit per square foot of bench space.

This average is higher than the largest yield of any plot in which coal ashes without peat was used, Table II; but with one exception, lower than the yield of any single plot in which coal ashes and moss peat were used, Table I. The average weight of the ripe fruits, and the per cent. of perfectly-shaped fruits were larger, where ashes and peat were used than where compost alone was used.

This comparison, of course, only holds for the compost under experiment. It is quite possible that composts made with soils of different character would have yielded larger crops.

Bituminous Coal Ashes alone, and the same with Moss Peat added.

The yields of the seven plots in Table II, 158 to 164 inclusive, are comparable with those of the seven plots in Table I, 150 to 156 inclusive, both having received the same amounts of fertilizer chemicals, and differing only in their position in the house and in the fact that there was no moss peat mixed with the ashes of the soil of plots 158 to 164.

The yields of fruit, in grams, were as follows:

Soil of Coal Ashes and Peat Moss	8914	8399	8011	6623	12575	10879	9210
Soil of Coal Ashes without Peat Moss	5008	6140	4447	4608	6104	5172	7385

In every case the yield was decidedly larger where moss peat had been used in the soil. The average of all was 9230 grams of fruit from the soil containing moss peat, and 5552 grams from the soil of ashes without it. These figures are equivalent to 0.88 pounds, and 1.44 pounds of fruit respectively from a square foot of bench space.

In view of the fact that no such differences attributable to the position of the plots in the house had been noticed in previous tests, the conclusion that the addition of moss peat to coal ashes makes them more suitable for the growth of tomatoes, seems a fair one.

TABLE IV. WEIGHT OF TOMATOES HARVESTED IN SUCCESSIVE WEEKS FROM EQUAL AREAS OF COMPOST AND OF COAL ASHES AND MOSS PEAT.

	Compost. Plots 168, 170 and 172,		Coal Ashes and Peat. Plots 150, 157, 166.	
1896. Week ending	For the week. grams.	Total. grams.	For the week. grams.	Total. grams.
Dec. 17.	2376	2376	2243	2243
" 24.	1610	3986	1658	3901
" 31.	2017	6003	1135	5036
1897.				
Jan. 7.	3022	9025	3755	8791
" 14.	114	9139	424	9215
" 21.	2488	11627	4367	13582
" 28.	2399	14026	2327	15909
Feb. 4.	2082	16108	2777	18686
" 11.	1992	18100	4730	23416

During the first four weeks of bearing, more fruit was gathered from the plots of compost: but after that the plots of coal ashes and peat yielded more fruit weekly than the others.

In one of the experiments described in our report for 1896, p. 220, two-fifths of the crop on ashes and peat ripened in a single week, while not more than one-fifth of the crop on compost ripened in the same period. No such difference, however, was noted in the experiments of the present year.

Effects of Nitrogen, Phosphoric Acid and Potash in the Fertilizer.

Inspection of Tables I and II shows :

1. With 55 grams of nitrogen and 24 grams of phosphoric acid in the fertilizer per plot, from 60 to 75 grams of fertilizer-potash yielded as large or a larger crop than 100 or 135 grams of potash.

2. With 65 grams of nitrogen and 24 grams of phosphoric acid in the fertilizer, 75 grams of fertilizer-potash yielded as large or a larger crop than either less or more potash.

3. With 75 grams of nitrogen and 24 grams of phosphoric acid, 75 grams of fertilizer-potash in coal ashes and peat yielded less than it did with less nitrogen; but in coal ashes alone 75 grams of nitrogen, 24 of phosphoric acid and 75 grams of potash in the fertilizer, yielded a larger crop than any other amounts.

4. In coal ashes and moss peat, with 75 grams of nitrogen and 24 of phosphoric acid, 135 grams of potash yielded more crop

than 75 grams, but rather less than was gathered from plot 155, which received 65 grams nitrogen with 24 of phosphoric acid and 135 of potash.

5. Plot 166, in addition to 24 grams of phosphoric acid and 135 grams of potash, received 75 grams of nitrogen as nitrate of soda and 34 grams of organic nitrogen in form of cotton seed meal. The yield was somewhat smaller than that of plot 157, which received the same fertilizers with exception of the organic nitrogen, and also smaller than that of two other plots in the same series.

6. The addition of fertilizers to plot 165, late in the season, seems to have had some effect on the growth, but little on the productiveness of the plants.

7. 65 grams of nitrogen, 24 grams of phosphoric acid, and from 75 to 135 grams of potash gave a larger yield than greater quantities of nitrogen and potash.

B. The Second Crop.

The results of these cultures appear in Tables V, VI, and VII. The first crop having indicated that the addition of peat to the ashes was desirable, 25 pounds of meadow peat* was added to each of plots 158 to 165 inclusive and 12.5 grams of precipitated calcium carbonate, being the amount necessary to neutralize the acid in this peat.

To each of the plots named was also added 0.23 grams of calcium carbonate for each gram of dissolved bone black used, to neutralize the acid of this material.

To each plot included in the three tables, excepting plot 172, were added the amounts of nitrogen, phosphoric acid and potash in form of nitrate of soda, dissolved bone black and muriate of potash, which had been removed by the crop growing from September to February and further amounts to raise the totals to the figures given in these tables. All the nitrogen returned to plot 166 at this time was in form of cotton seed meal.

It is assumed in this calculation that the nitrate added in September, so far as it was not taken by the crop, remained in the soil. We have no means of proving whether it did or did not. It is well understood that if the conditions are favorable to

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* This peat contained a considerable quantity of water. The dry matter in the 25 pounds of meadow peat was the same as in 3 pounds of the moss peat.

TABLE V.—TOMATO CULTURES IN BITUMINOUS COAL ASHES AND PEAT MOSS. FEB. TO JULY, 1897.

Fertilizers.		Plot 150.	Plot 151.	Plot 152.	Plot 153.	Plot 154.	Plot 155.	Plot 156.	Plot 157.	Plot 166.
Nitrate of Soda,	grams	461.5	461.5	461.5	461.5	461.5	461.5	532.5	603.5	
Cotton Seed Meal,	"	....	....	....	....	....	....	....	....	384.24
Nitrogen,	"	65	65	65	65	65	65	75	85	109
Dissolved Bone Black,	"	141 36	141.36	141.36	141.36	141.36	141.36	141.36	141.36	141.36
Phosphoric Acid,	"	24	24	24	24	24	24	24	24	24
Muriate of Potash,	"	129	161.75	215	290.25	161.75	290.25	365.5	365.5	290.25
Potash,	"	60	75	100	135	75	135	170	170	135
Yield.										
Total yield of fruits, fresh weight, grams		7698	7623	8089	6222	8223	8467	7637	10113	13210
" " vines, air dry, "		437	506	472	442	447	528	420	709	673
" " roots, " "		31	63	49	32	65	35	37	85	90
Average yield of fruits per plant, grams		1283	1271	1393	1037	1371	1411	1206	1686	2201
" " " pounds		2.83	2.8	3.07	2.29	3.02	3.11	2.64	3.72	4.85
" number of fruits per plant		10.6	11.1	13	10.3	13.8	13.6	11.8	14.5	14.5
" weight of ripe fruits, grams		133	119.7	115.5	74.4	108.2	107.9	116.6	124.5	155.9
Per cent of perfect-shaped fruits		54.6	74.6	74.3	72.5	72.3	63.4	63.3	59.7	73.5
Average yield of fruits per square foot of bench area, grams		555.01	549.6	583.2	448.5	592.9	610.5	550.6	729.1	952.41
Average yield of fruits per square foot of bench area, pounds		1.21	1.21	1.28	.99	1.30	1.34	1.21	1.61	2.10

TABLE VI.—TOMATO CULTURES IN BITUMINOUS COAL ASHES WITH PEAT MOSS. FEB. TO JULY, 1897.

Fertilizers.	Plot 158.	Plot 159.	Plot 160.	Plot 161.	Plot 162.	Plot 163.	Plot 164.	Plot 165.†
Nitrate of Soda, grams	461.5	461.5	461.5	461.5	461.5	461.5	532.5	603.5
Nitrogen, "	65	65	65	65	65	65	75	85
Dissolved Bone Black, "	141.36	141.36	141.36	141.36	141.36	141.36	141.36	141.36
Phosphoric Acid, "	24	24	24	24	24	24	24	24
Muriate of Potash, "	129	161.75	215	290.25	161.75	365.5*	365.5	365.5
Potash, "	60	75	100	135	75	135	170	170
Yield.								
Total yield of fruits, fresh weight, grams	6613	7310	5298	9561	9221	7664	8844	11963
" " " vines, air dry, "	365	358	322	560	503	503	576	545
" " " roots, " " "	91	33	35	87	43	79	88	64
Average yield of fruits, per plant, grams	1102	1218	883	1593	1537	1277	1474	1994
" " " " " " pounds	2.43	2.68	1.95	3.41	3.39	2.82	3.25	4.40
Average number of fruits per plant	10.1	10	8 5	15	14 5	12.8	14.3	16
Average weight of ripe fruits, grams	118	141.4	120.1	113.5	116.8	114.8	110.6	131
Per cent. of perfect-shaped fruits	70.5	58.3	52.9	77.7	79.3	70.1	66.2	81.6
Average yield of fruits per square foot of bench area, grams	476.8	527.1	382.7	689.3	664.8	552.5	637.6	862.5
Average yield of fruits per square foot of bench area, pounds	1.05	1.16	.84	1.52	1.46	1.22	1.41	1.90

* Increased from 290.25, by mistake.

† This plot received a portion of its fertilizers in liquid form. See page 280.

the activity of denitrifying organisms, the nitrates of the soil may be rapidly and largely destroyed with the escape of nitrogen gas. While the soil was porous and never saturated with water, it cannot be asserted that this denitrifying process did not go forward in our soils.

Compost alone and with added Fertilizer Chemicals.

The yields of the six plots which were filled with compost appear in Table VII.

TABLE VII.—TOMATO CULTURES IN COMPOST.

FEB. TO JULY, 1897.

Fertilizers.	Plot 167.	Plot 168.	Plot 169.	Plot 170.	Plot 171.	Plot[*] 172.
Nitrate of Soda, grams......	60.35	none	120.7	none	241.4	none
Nitrogen, "	8.5	......	17	......	34	......
Dissolved Bone Black, "	23.56	none	47.12	none	94.24	none
Phosphoric Acid, "	4	......	8	......	16	......
Muriate of Potash, "	45.15	none	90.30	none	180.6	none
Potash, "	21	......	42	......	84	......
Yield.						
Total yield of fruits, fresh weight, grams	5676	8905	8514	8646	8459	5942
Total yield of vines, air dry, grams.	476	534	442	519	404	418
" " " roots, " " .	101	60	60	60	53	62
Average yield of fruits per plant, grams	946	1484	1419	1441	1410	990
Average yield of fruits per plant, pounds	2.08	3.27	3.13	3.18	3.11	2.18
Average number of fruits per plant	8.8	13.6	13.1	15.1	14.3	10.5
" weight of ripe fruits	113	114.5	107.7	96.7	102.7	102.4
Per cent. of perfect-shaped fruit...	62.2	71.8	92.4	84.6	82.5	46
Average yield of fruits per square foot of bench area, grams.......	409.2	642	613.8	623.3	609.8	428.4
Average yield of fruits per square foot of bench area, pounds......	.90	1.41	1.35	1.37	1.34	.94

To one of them, plot 172, no fertilizer chemicals had been applied. Two of them, 168 and 170, after the first crop had been taken off, had returned to them in form of fertilizer chemicals only as much nitrogen, phosphoric acid and potash as had been removed by the crop.

To the three others, 167, 169 and 171, fertilizer chemicals in the amounts given in the tables were applied before the first crop was planted, and what was planted and what was removed by the first crop was supplied by chemicals before the second crop was planted.

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[*] Fertilizers were not replaced after first crop.

The smallest crop was from plot 167, which had received a small amount of fertilizer chemicals in the fall and again when the second crop was set. Somewhat larger was the yield from plot 172, to which no fertilizer chemicals had been applied at any time. The yields from plots 168 and 170, to which no fertilizer chemicals were applied for the first crop, are both larger than those from plots 169 and 171, to which considerable amounts of fertilizer chemicals had been added at that time.

The general result agrees with that of the first crop. No increase of yield followed the addition of fertilizer chemicals to rich compost, but rather a depression of the yield.

Compost compared with a mixture of Coal Ashes, Peat and Chemicals.

The three largest yields of tomatoes raised in compost, Table VII, are 8905, 8646, and 8514 grams; an average of 8688 grams or 1.38 pounds of fruit to one square foot of bench space.

This average is surpassed by the yield of six plots, 157, 161, 162, 164, 165 and 166, which were filled with coal ashes and peat with added chemicals, from which the average yield was 1.66 pounds of fruit per square foot of bench space.

Effects of Nitrogen, Phosphoric Acid and Potash in the Fertilizer.

The figures given in Tables V and VI do not show any very clear relation between the quantity of fertilizers used and the yield of fruit. This is no doubt to be explained in part by the various accidents which befel the second crop, especially the rot, due to the tomato Macrosporium, which, as has been already said, did a good deal of damage. In general, the plots which received the larger quantities of nitrogen and potash, Nos. 161, 162, 164, 165, 157 and 166 gave the larger yield.

The largest yield of all, 2.1 pounds of fruit per square foot of bench space, was from plot 166, to which some organic nitrogen was added for the first crop and to which the nitrogen applied for the second crop was all in form of cotton seed meal.

PARTIAL ANALYSES OF TOMATO FRUIT.

On June 9th samples consisting of from eight to thirteen fruits were picked from the three plots, 150, 157 and 171, and analyzed. As is seen in the tables, plots 150 and 157 contained coal ashes and peat fertilized with chemicals; plot 171 contained compost, to which chemicals had also been added. Plot 157 received considerably more nitrogen and potash in the fertilizer than 150.

	Plot 150.	Plot 157.	Plot 171.
Average weight of one fruit	132	184	98
Per cent. of water lost in air drying	95.44	95.54	93.62
nitrogen	0.145	0.146	0.179
phosphoric acid	0.055	0.051	0.056
potash	0.227	0.280	0.388

The fruit from the plot filled with compost was smaller than that from those containing ashes and peat, it contained less water by about two per cent., and a somewhat higher percentage of nitrogen and potash.

THE QUANTITIES OF NITROGEN, PHOSPHORIC ACID AND POTASH CONTAINED IN THE TOMATO CROPS.

These were determined in each of the plots in the experiment. It is not necessary to give here all the results in detail. The figures for four plots may suffice. Plots 150 and 157 contained coal ashes and peat moss, the former with a minimum supply of fertilizer chemicals, the latter with nearly the maximum. Plots 169 and 172 contained compost; to the former were added chemicals to supply the nitrogen, phosphoric acid and potash removed in the first crop, to 172 no chemicals were added.

TABLE VIII.—GRAMS OF NITROGEN, PHOSPHORIC ACID AND POTASH IN THE SECOND CROP, FEB. TO JULY, 1897.

	Plot 150.			Plot 157.			Plot 169.			Plot 172.		
	Nitrogen.	Phos. Acid.	Potash.	Nitrogen.	Phos. Acid.	Potash.	Nitrogen.	Phos. Acid.	Potash.	Nitrogen.	Phos. Acid.	Potash.
Roots	.53	.13	.24	1.22	.28	1.04	1.03	.28	.88	1.18	.38	1.53
Vines and Leaves	10.58	2.05	12.67	17.16	3.05	35.73	7.21	1.72	18 52	5.89	1.88	11.24
Fruit	11.16	4.23	17.47	14 77	5.16	28.32	15.24	4.77	33.03	10.64	3.23	23.06
Total	22.27	6.41	30.39	33.15	8.49	65.09	23.48	6 77	52.43	17.71	5.59	35.83

SUMMARY.

The results of the foregoing observations may be summarized as follows:

1. The yield of tomatoes from benches filled with a rich compost was on the average larger when no fertilizer chemicals were added. The addition of chemicals rather depressed the yield of tomatoes from compost.

2. From a mixture of coal ashes and peat with fertilizer chemicals larger crops of tomatoes were produced than from a rich compost of turf and manure, in each of the three years covered by our experiments.

3. Tomatoes are much more productive when grown in a mixture of coal ashes and moss peat than when grown in coal ashes without peat.

4. In the tests here reported the plants growing in compost yielded more fruit during the first month than those in ashes and peat. From then on the weekly yield was largest from the plots of ashes and peat.

5. The best yields of tomatoes have been from plots of the mixture of coal ashes and moss peat already described, to which had been added per 100 square feet of bench space, 6.4 pounds of nitrate of soda, 1 pound of dissolved bone black and 2.4 pounds of muriate of potash. The amounts of fertilizer chemicals which can be profitably used depends on the season of the year in which the crop is raised, the watering and, doubtless, on other conditions whose effects are not as well understood.

The crop which is in the house from September to February will not bear as much fertilizer as the following one, growing from February to July, because of the smaller amount of sunlight in the first period, which the plants can utilize. In the first case the hours of sunlight per day decrease as the foliage increases; in the second case this is reversed.

Plants which receive large quantities of freely soluble plant food in the soil of ashes and peat have a much less extensive root system than those growing in compost, and when fully grown are likely, in consequence, to wilt more easily.

II. CARNATION CULTURES, SEASON OF 1896-97.

The following experiments were undertaken to study the fertilizer requirements of this crop when raised under glass.

Benches and Plots.—Plots 174 to 185 inclusive (see plate, page 309) were used for the cultures. With exception of three, which will be specially noted, these plots have an area of 14.53 square feet and a depth of 5¾ inches.

Soils and Fertilizers.—Most of the plots were filled with bituminous coal ashes, to which was added 3 per cent. by weight of moss peat and weighed quantities of fertilizer chemicals. The method of preparing this mixture has already been described on page 278 of this Report.

Two plots were filled with the rich compost, described on page 278. In each case the mixture or the compost filled the plots to a depth of five inches. The fertilizers for each plot were evenly scattered over the surface of the soil (compost or ashes) and very thoroughly mixed with it by shoveling over.

Plants.—In plots 174 to 181 were set plants bought of Mr. C. W. Ward of Queens, N. Y., which were of three varieties, Daybreak, William Scott and Alaska.

These were from cuttings made in March and April by Mr. Ward, rooted under glass and set in the field on well-manured soil, about May 10th, in rows 3 feet apart, 10 inches apart in the row. They were cultivated every week, and all flower buds were pinched off till they were shipped to the Station late in September.

In plots 182A to 185 were set plants raised at the Station from cuttings of the Daybreak, William Scott, Garfield and Lizzie McGowan varieties. They were of about the same size and shape as the bought plants.

Eighteen plants, six of each variety, Daybreak, Scott and Alaska, were set in each of the plots, 174–181, on the 2d and 3d of October. Very little soil adhered to the roots, and this was not removed. Many plants were full of buds, especially those of the Alaska variety, but all buds were pinched off at this time to make the plants as nearly comparable as possible.

The young plants were checked somewhat by transplanting and shipping. On Oct. 6th a few of them were still wilted, the William Scott variety suffering the most, and a week after setting many appeared to be dying; but they soon began to improve and we lost none of them.

The plants were supported by wire netting having three meshes to the inch and cut into strips fifteen inches wide and thirty inches long. Each strip was folded lengthwise to the form of a gable roof and was placed between two rows of plants, serving to support the foliage and to secure a free circulation of air with room for watering.

Notes during growth.—The temperature of the house was kept at about 60° F. by day and 50°–55° by night, mostly from bottom heat, and free ventilation was given whenever possible. The walks of the house were wet down every morning in winter and several times daily in the warmer spring weather.

At first the plants were syringed every bright day with water, but as bacteriosis began to develop, water was withheld till spring, when it was used again to keep off the red spider.

The house was fumigated every week with tobacco to destroy the green fly (Aphis). All lateral buds were pinched off and only the terminals allowed to open. All the trimmings, consisting of lateral buds, dead leaves, etc., were carefully saved from each plot separately and dried for analysis.

The Daybreak variety was the first to blossom, Dec. 1st.

The first blooms of the Alaska variety were inferior, many having a broken calyx. Later this variety gave some excellent flowers.

Rust, *Uromyces caryophyllinus*, appeared in all the plots of purchased plants. Infested leaves were hand-picked and this, together with sprayings of ammoniacal copper carbonate solution, held this trouble in check.

In January the William Scott variety was attacked by the disease known as "Die-back," or "Stem-rot." In March two plants, killed by this disease, were taken from plot 178 and replaced by potted plants; one was taken from each of plots 174 and 180, two each from plots 177, 178 and 179, and three from plot 176.

When the experiment was finished only plots 175 and 181 contained six plants of this variety. Plots 174 and 180 had five plants, plots 178 and 179 four, and plots 176 and 177 three plants each. The other varieties did not suffer at all from this trouble. This disease has been discussed on page 175 of this Report.

The William Scott and a few of the Lizzie McGowan plants produced buds which did not open. The petals grew together within the bud. Such buds are said to be "sleepy." The trouble is a common one and is discussed on page 302.

The plants continued to blossom until harvested July 1st, but the later blooms were small. The foliage also became paler in color, owing possibly to exhaustion of the plant food in the soil as well as to the attacks of red spider.

Except where specially stated, no top dressing or fertilizer in any form was supplied to the plots after the plants were set.

Harvesting.—The blooms were picked when fully open as they are usually picked for market. The diameter of each bloom and the length of stem were recorded together with any characteristic of the flower, such as bursting of the calyx, poor color, substance, etc. If blooms were considered perfect, this was also noted. The fresh weights of the blooms of the separate varieties from each plot were recorded at each picking. Chemical analyses were made of cut flowers of each of the three varieties and of Daybreaks and William Scotts from the plots having least and most fertilizers added to the soil. The plants were harvested July 1st, 1897. The roots were carefully taken out, washed and cut up with the tops. The whole was then dried for analysis; each variety growing in plots 174, 175, 176, 177, 178, 179, 180 and 181 was kept separate, but all plants from each of the other plots were put together.

TABLE IX.—CARNATION CULTURES IN BITUMINOUS COAL ASHES AND MOSS PEAT. 1896–1897.

Fertilizers.	Plot 174.			Plot 175.			Plot 176.		
Nitrate of Soda, grams	142			177.50			213		
Equivalent Nitrogen, "	20			25			30		
Dissolved Bone Black, "	47.12			47.12			47.12		
Equivalent Phosphoric Acid, "	8			8			8		
Muriate of Potash, "	75.25			75.25			75.25		
Equivalent Potash. "	35			35			35		
Yield.									
Weight of cut flowers, grams	1845 (2397)*			2363 (3026)*			2336 (2722)*		
Number " "	294 (352)*			287 (358)*			299 (347)*		
Varieties	Daybreak.	Wm. Scott.	Alaska.	Daybreak.	Wm. Scott	Alaska.	Daybreak.	Wm. Scott.	Alaska.
Weight of cut flowers, grams	961	552	884	1516	663	847	1509	386	827
Number " "	144	58	150	152	71	135	166	48	133
Average number of flowers per plant	24	9.6	25	25.3	11.8	22.5	27.6	8	22.1
Average diameter of flowers, inches	2.19	2.21	1.99	2.25	2.23	2.1	2.21	2.11	2.02
Average length of stem, inches	13.8	13.9	9.1	14.4	13.3	10.1	13.9	12.4	10.2
Average weight of flowers, grams	8.8	9.5	5.8	9.9	9.3	6.2	9.6	8.0	6.2

Discussion of the Results.—The results of these tests are given in the following tables. Table IX includes the plots which were filled with bituminous coal ashes and peat moss and dressed with fertilizer chemicals.

Each of plots 174, 175, 176 and 177 received 8 grams of phosphoric acid and 35 grams of potash in form of dissolved bone black and muriate of potash.

Nitrogen was, however, supplied to the four plots in unequal amounts. Plot 174 received 20 grams; plot 175, 25 grams; plot 176, 30 grams, and plot 177, 40 grams.

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* Including Wm. Scott variety.

The effect of the difference in nitrogen supply is to be noted in the number of cut flowers gathered.

It is evident that the Wm. Scott variety cannot be regarded in considering the effect of fertilizers, for at harvest only plot 175 had its full number of plants. Plot 174 had lost one, and 176 and 177 had each lost three plants by disease.

The largest total number of blooms, excluding the Scott, gathered from either of these four plots, was from plot 176, which had received 30 grams of nitrogen. Plot 177, with 40 grams of nitrogen, yielded most Daybreaks, (by far the most prolific variety in these tests), while plot 174, with only 20 grams of nitrogen, yielded the most Alaskas. Plot 175, with 25 grams of nitrogen, yielded the largest blooms of both the Daybreak and Alaska varieties, though the difference in this regard between the plots was small. On the whole, plot 176 was the most profitable of the four, yielding nearly 25 blooms per plant, or 3070 blooms per 100 square feet of bench space. The difference of yield between the four is, however, very slight.

TABLE IX.—CARNATION CULTURES IN BITUMINOUS COAL ASHES AND MOSS PEAT. 1896–1897.—*Continued.*

Plot 177.	Plot 178.	Plot 179.	Plot 180.
284	177.50	177.50	177.50
40	25	25	25
47.12	70 98	47.12	47.12
8	12	8	8
75.25	75.25	96.75	129
35	35	45	60

2002 (2305)*			2459 (2660)*			2217 (2473)*			2637 (3188)*		
287 (320)*			315 (342)*			288 (321)*			328 (394)*		
Day-break.	Wm. Scott	Alaska.	Day-break.	Wm. Scott.	Alaska.	Day-break.	Wm. Scott.	Alaska.	Day-break.	Wm. Scott.	Alaska.
1316	303	686	1572	201	887	1462	256	755	1608	551	929
172	33	115	162	27	153	164	33	124	184	66	144
28.6	5.5	19.1	27	4 5	25.5	27.3	5.5	20.6	30.6	11	24
2.2	2.28	2.03	2.21	2.14	1.91	2.21	2.15	1.98	2.17	2.19	1.98
13.7	11.8	9.9	13 9	12.1	10.2	13.1	11.14	10.2	13.6	12.3	10 3
9.3	9.1	5.9	9.7	7.4	5.8	8.9	7 7	6.0	8.7	8.3	6.4

In this experiment, with 8 grams of phosphoric acid and 35 grams of potash, 30 grams of nitrogen were enough to yield a maximum crop.

The yield from plot 178, which received the same quantities of nitrogen and potash as plot 175, but a half more phosphoric acid, 12 grams, shows that 8 grams was too small a quantity of phosphoric acid to give a maximum yield with the amounts of nitrogen and potash used on plot 175. The additional phosphoric acid on plot 178 did not cause the plants to mature or blossom any earlier than on the other plots.

Plots 179 and 180, in connection with plot 176, show the effects of larger quantities of fertilizer-potash. These three plots received like amounts of nitrogen and phosphoric acid. Plot 175, with 35 grams of potash, yielded 287 blossoms; plot 179, with 45 grams of potash, yielded 288; and plot 180, with 60 grams of potash, yielded 328 blossoms, the largest number in the series. On the average over 27 blossoms were gathered from each plant of the Alaska and Daybreak varieties, or 3360 per 100 square feet of bench space.

The whole series indicates that to secure a maximum crop, *at least* 40 grams of nitrogen, 12 of phosphoric acid and 60 of potash need to be used, and perhaps still larger quantities. Calculated for 100 square feet of bench space these amounts are:

Nitrogen,	9.7	ounces, equivalent to	3 pound	14 oz.	Nitrate of Soda.
Phosphoric Acid,	2.9	" "	" 1	" 1 "	Dissolved Bone Black.
Potash,	14.6	" "	" 1	" 13 "	Muriate of Potash.

The profit from any variety of carnations depends both on the number of blossoms and on the season of most abundant bloom.

The Wm. Scott variety was badly affected with stem-rot and had many "sleepy" flower buds.

The yields of the other two varieties for each month of the test, from all the plots in Table IX, 174 to 180 inclusive, are as follows:

	Daybreak. Number of blossoms.	Alaska. Number of blossoms.
December	88	14
January	100	61
February	210	115
March	117	376
April	122	112
May	163	87
June	343	190
	1143	955

During the months of Dec., Jan. and Feb. twice as many blossoms of the Daybreak variety were gathered as of the Alaskas. But in March the Alaskas blossomed very freely, yielding in that one month three times as many blossoms as the Daybreaks. In every other month, however, more blossoms were picked from the Daybreaks.

Plot 181 was filled with the compost described on page 278, to which no fertilizer chemicals were added. It will be seen that the yield of blooms of the Alaska and Daybreak varieties were smaller than in any of the plots filled with coal ashes and peat and supplied with fertilizer chemicals.

It is noteworthy, however, that in this plot the Wm. Scott variety was not seriously attacked by stem-rot or die-back, and gave a larger yield of blooms than in any other plot, though not as many as either of the other varieties.

TABLE X.—CARNATION CULTURES. 1896–1897.

Fertilizers.	Plot 181.*			Plot 182A †	Plot 182B.†	Plot 183.§	Plot 184.*	Plot 185.¶
Nitrate of Soda, grams	....			136.82	136.82	125.09	71.	284.
Equivalent Nitrogen, "	....			19.2	19.2	17.6	10.	40.
Dissolved Bone Black, "	....			......	45.4	41.51	23.56	70.68
Equivalent Phosphoric Acid, ... "	....			......	7.6	7.	4.	12.
Muriate of Potash, "	....			72.48	......	62.29	21.5	96.75
Equivalent Potash, "	....			33.6	......	28.7	10.	45.
Yield.								
Weight of cut flowers, grams	1452 (2305)‡			2916	2250	2676	2562	2791
Number of cut flowers...	223 (326)‡			328	266	289	313	327
Varieties.	Daybreak.	Wm. Scott.	Alaska.	Daybreak, Garfield, Lizzie McGowan.		Daybreak, Wm. Scott, Garfield, Lizzie McGowan.		
Average number of flowers, per plant	18.1	17.1	19.	18.2	14.7	19.2	17.9	18.1
Average diameter of flowers, inches	2.12	2.23	1.96	2.23	2.16	2.21	2.16	2.14
Average length of stem, inches	13.2	13.2	9.7	13.7	13.	13.4	12.4	12.7
Average weight of flowers, grams...........	7.6	8.2	5.4	8.8	8.4	9.2	8.1	8.5

* Soil of Compost. Plot 184 received 10 grams nitrogen at setting time and 4 grams phosphoric acid and 10 grams potash Feb: 1st.

† Calculated from half-plots containing 9 plants each with an area of 6 96 square feet.

‡ Including Wm. Scott variety.

§ Ashes alone; plot has an area of 12.83 square feet and contained 15 plants.

¶ Soil of coal ashes and moss peat. Received 30 grams nitrogen, 8 phosphoric acid and 35 potash at setting and the remainder Feb. 1st.

Plots 182 A and 182 B were filled with the mixture of bituminous coal ashes and peat already described. Both received 19 grams of nitrogen, but plot A received no phosphoric acid and B no potash. The varieties grown were Daybreak, Garfield and Lizzie McGowan, so that strict comparison with other plots is not possible. The crop apparently was able to get most of the phosphoric acid which it required from the soil, but this was not equally true regarding potash.

Plot 183, which contained only 15 plants (those above-mentioned contained 18), and was filled with coal ashes without peat, yielded so many blooms as to make it seem likely that the mixture of peat with the coal ashes is not as essential for raising carnations as for some other crops.

NITROGEN, PHOSPHORIC ACID AND POTASH TAKEN BY THE CROP.

The moss peat contained about 0.50 per cent. of nitrogen in very inert form, as had been proved by previous tests with tomatoes. The bituminous coal ashes contained a considerable amount of available potash and phosphoric acid, as has been seen from the cultures on plots 182 A and B.

The young plants also contained each of these ingredients. Analyses showed that the 18 plants set in each plot contained 10.47 grams of nitrogen, 3.44 grams of phosphoric acid and 16.00 grams of potash.

During the growing season a number of analyses of cut flowers —including the stems, as picked for market—were made with the following results in per cent.:

	Nitrogen.	Phosphoric Acid.	Potash.
Daybreaks, plot 174	.33	.12	.61
16 blossoms from various plots of ashes and peat	.44	.14	.66
16 blossoms from soil of compost	.42	.15	.79
Alaskas, from plot 181	.39	.17	.69
23 blossoms from various plots of ashes and peat	.42	.15	.63
Wm. Scott, from various plots of ashes and peat	.39	.16	.66
from soil of compost	.39	.20	.78
from plot 174	.33	.14	.59
Average of all	.39	.15	.68

It is evident from these analyses that no considerable error will be introduced by assuming that the cut flowers of all varieties

TABLE XI.—CARNATION CULTURES, 1896–1897.

AMOUNTS OF NITROGEN, PHOSPHORIC ACID AND POTASH IN THE FERTILIZERS APPLIED AND IN THE CROPS HARVESTED.

Plot.	No. 174.			No. 175.			No. 176.			No. 177.			No. 178.			No. 179.			No. 180.		
Plant Food.	Nitrogen.	Phos. Acid	Potash.	Nitrogen.	Phos. Acid.	Potash.	Nitrogen.	Phos. Acid.	Potash.	Nitrogen.	Phos. Acid.	Potash.	Nitrogen.	Phos. Acid.	Potash.	Nitrogen.	Phos. Acid.	Potash.	Nitrogen.	Phos. Acid.	Potash
In the Plants set	10.47	3.44	16.00	10.47	3.44	16.00	10.47	3.44	16.00	10.47	3.44	16.00	10.47	3.44	16.00	10.47	3.44	16.00	10 47	3.44	16.00
In the Fertilizers	20	8	35	25	8	35	30	8	35	40	8	35	25	12	35	25	8	45	25	8	60
Total	30.47	11.44	51.00	35.47	11.44	51.00	40.47	11.44	51.00	50.47	11.44	51.00	35.47	15.44	51.00	35.47	11.44	61.00	35.47	11.44	76.00
In the Harvest.																					
In the Blooms...	9.35	3.60	16.30	11.80	4.54	20 58	10.62	4.08	18.51	8.99	3.46	15.67	10.37	3.99	18.09	9.64	3.71	16.81	12.43	4.78	21.68
In the Plants* ..	12.19	5.15	26.17	14.51	6.13	28.32	14.05	5.41	25.30	14.13	4.53	23.83	13.12	5.22	27.47	11.53	4.30	26.68	13.10	5.17	32.51
Total	21.54	8.75	42.47	26 31	10.67	48.90	24.67	9.49	43.81	23.12	7.99	39.50	23.49	9.21	45 56	21.17	8.01	43.49	25.53	9.95	54 19

Plot.	No. 181.§			No. 182A.†			No. 182B.†			No. 183.‡			No. 184.§			No. 185.§		
Plant Food.	Nitrogen.	Phos. Acid.	Potash.	Nitrogen.	Phos. Acid.	Potash.	Nitrogen.	Phos. Acid.	Potash.	Nitrogen.	Phos. Acid.	Potash.	Nitrogen.	Phos. Acid.	Potash.	Nitrogen.	Phos. Acid.	Potash.
In the Plants set..................	10.47	3.44	16.00	10.47	3.44	16.00	10.47	3 44	16.00	8.73	2.85	13.30	10.47	3.44	16.00	10.47	3.44	16
In the Fertilizers..................	§	§	§	38.40	.....	67.20	38.40	15.20	....	17.60	7.00	28.70	§	§	§	40	12	45
Total	......	......	....	48.87	3.44	83.20	48.87	18.64	16.00	26.33	9.85	42.00	......	......	....	50.47	15.44	61
In the Harvest.																		
In the Blooms......................	8.99	3.46	15.67	11.37	4 37	19.83	8.78	3.37	15.30	10.43	4.01	18.20	9.99	3.84	17.41	10.88	4.18	18.97
In the Plants*	12.05	6.37	27.51	14.68	6.26	31.20	15.90	6.48	18.40	13.84	4.43	27.14	16.66	8.03	40.90	21.00	7.32	37.23
Total	21.04	8.83	43.18	26.05	10.63	51.03	24.68	9.85	33.70	24.27	8.44	45.34	26.65	11.87	58.31	31.88	11.50	56.20

* Including roots. † Calculated to full plot. ‡ 15 plants. § Compost.

and in all the plots have the same composition; the average of all the analyses given above.

Table XI gives the calculated amounts of nitrogen, phosphoric acid and potash contained in the plants and in the blossoms from each plot and also the amounts of these ingredients in the fertilizers applied and the plants set in each plot.

As appears in the table there was about as much nitrogen, phosphoric acid and potash in the plants which were set in the benches as there was in the blossoms which were picked from them during six months.

SLEEPY FLOWERS.

As is noted on page 295, some buds of the Wm. Scott and Lizzie McGowan varieties failed to open. Growers call such buds or flowers "sleepy," and the trouble is not an uncommon one. The buds are to all appearance normal up to the time when the petals should break through the opening calyx. But instead of opening, like the normal flower, the petals cohere and though left upon the plant for several days do not expand. Such blooms of course are worthless. Upon a close examination the petals are seen to be actually united and therefore cannot expand into a perfect flower. To separate them it is necessary to break apart the cells of the petals; they are grown together where they should be separate. That the petals are not merely stuck together is shown by soaking them in water or alcohol. The bases of the petals however do not cohere, but are entirely free in the calyx tube.

In a discussion at the meeting of the American Carnation Society in 1896, Dr. J. C. Arthur of the Purdue University Experiment Station, said—"Placing a thin cross-section of the abnormal buds under the microscope, it is readily seen that they are so closely attached, that the projecting cells fit together as completely as if they had been brought into contact by heavy pressure. Normally, the cells are evenly-rounded on the free side, as comes about naturally from the usual internal pressure of the sap. The abnormal petals appear to have become united when very young."*

Regarding the cause of the trouble, there has been much speculation, but the prevailing opinion amongst growers is that it results from too much nitrogen in the soil. Some believe that nitrate of soda alone is responsible, while others claim that the same trouble has been produced by nitrogen in organic forms. So far as we are aware, there has been no thorough study of the subject.

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* American Gardening, Vol. XVII, No. 63, March 7, 1896.

In the cultures described on the preceding pages of this Report, a record was kept of all abnormal buds, and this record, together with the quantities of nitrogen applied to the several plots, may be seen in the following table. The averages are for the Wm. Scott variety only.

TABLE XII. NITROGEN AND "SLEEPY FLOWERS."

	Plot 174.	Plot 175.	Plot 176.	Plot 177.	Plot 178.	Plot 179.	Plot 180.	Plot 183.	Plo 185.
Nitrate-nitrogen, grams	20	25	30	40	25	25	25	20	40
Average No. of sleepy flowers per plant	2.4	4.3	3	6.3	2.7	2	3.8	.16	3.5

Although plot 177, to which 40 grams of nitrate-nitrogen was added, produced a greater number of sleepy flowers than any other plot, plot 185, with the same quantity of fertilizer-nitrogen, produced less than plots 175 and 180, which had only 25 grams of nitrogen. There is no very close relationship between the amount of fertilizer-nitrogen and the number of "sleepy" flowers found in our cultures.

SUMMARY.

1. Carnations have been successfully raised by us in a soil composed of coal ashes and moss peat, with commercial fertilizers.

The largest yield obtained was an average of 27.3 blooms per plant or 3,384 blooms per 100 square feet of bench space. The average yield from seven plots was 25 blooms per plant or 2,703 per 100 square feet. This is an average of Daybreaks and Alaskas, the Wm. Scott variety being excluded from the average. The blooms were of fair size, having an average diameter of 2.1 inches.

2. The largest crop was gathered from the plot in which 40 grams of nitrogen, 12 of phosphoric acid and 60 of potash were mixed with the ashes and peat. This is equivalent to a dressing, per 100 square feet of bench space, of 3 lbs. 14 oz. of nitrate of soda, 1 lb. 1 oz. of dissolved bone black and 1 lb. 13 oz. of muriate of potash.

3. The William Scott variety was badly affected by stem rot and bore many "sleepy" buds.

The Daybreak yielded about 20 per cent. more blooms than the Alaska variety and during December, January and February yielded twice as many.

4. There is no considerable difference in the percentage amount of nitrogen, phosphoric acid and potash in the fresh picked blossoms of the three varieties tested, the average quantities being

Nitrogen	0.39 per cent.
Phosphoric acid	0.15 "
Potash	0.68 "

		Nitrogen.	Phosphoric acid.	Potash.
10,000 Daybreak blooms weigh	191 pounds and contain	12 oz.	5 oz.	1 lb. 5 oz.
10,000 Wm. Scott " "	187 " " "	11.7 "	4.8 "	1 " 4.6 "
10,000 Alaskas " "	134 " " "	8.3 "	3.4 "	0 " 14.8 "

5. A single plot filled with the rich compost described on page 278, did not yield as many blooms as the mixture of ashes and peat.

III. EXPERIMENTS WITH RADISHES, SEASON OF 1896-1897.

These tests are a continuation of those described in the twentieth Report of this Station for 1896, pp. 222–226, and were made on plots 186 to 201 of the center bench of the carnation house, F, (see plate I, p. 309). Plots 196, 197, 200 and 201 were filled with the rich compost already described, p. 278. Plot 199 was filled with sifted bituminous coal ashes. All the other plots in this experiment were filled with the mixture of coal ashes and moss peat, which has already been described on page 278 of this Report.

Seed of the Cardinal Globe variety of radish, bought of H. A. Dreer, of Philadelphia, was sifted through a screen with twelve meshes to the inch, and all which passed through the screen—nearly one-third of the whole—was rejected.

Only plot 198 was sown with unscreened seed.

First Crop.

Seed was planted Oct. 21st; each plot had nine rows, five inches apart, with 22 seeds in each row, or 198 for the whole plot. Five days after sowing the young plants began to appear.

On November 16th, when the plants were about half grown, seed for a second crop was sown between the rows of plots 192, 193, 200 and 201. At this time the radishes growing in coal ashes and peat were larger than those in compost. The first radishes were pulled for market from the coal ashes and peat on November 25th, and the last of the crop were pulled on December 7th. At this time the compost plots were just beginning to produce radishes large enough for market, and on December 14th the last radishes were pulled from compost plots.

In all cases the radishes were pulled when three-fourths of an inch in diameter, with the exception of a few plants taken at the last pulling, which had not reached marketable size. These were pulled and weighed with the others, and number of plants noted.

Second Crop.

The second sowing was made December 12th, in coal ashes and peat, and three days later in compost. Seed of the French Breakfast variety was sown for the second and third crop in plot 198, but this variety proved inferior to Cardinal Globe for forcing.

The crop grown from seed planted between the rows had matured and all the radishes grown in coal ashes and peat had been pulled by January 5th; those grown in compost by January 11th.

The second regular crop was all harvested by February 1st from soil of coal ashes and peat. In plot 199 (coal ashes alone) all were pulled by February 3d, but many of the plants were too small for market. The foliage of the plants in this plot was smaller than in the others and many of the leaves turned yellow about the edges. On February 15th all radishes of the second crop had been pulled from the plots filled with compost.

Third Crop.

Seeds for the third and last crop were sown February 3d and February 19th, respectively, in coal ashes and in compost; the crop from the former was all harvested by March 23d and from the latter by March 31st. On these respective dates three successive crops had been gathered and a fourth had been grown on the plots where seeding between the rows was practiced.

The house temperature was kept at about 60° F. during the daytime and 5° or 8° lower during the night. All plants, except those in the sub-irrigated plots, were freely sprinkled overhead and watered when necessary. The house was well ventilated.

In plots 186, 187, 188 and 189 the calculated amounts of nitrogen, phosphoric acid and potash which had been removed in each crop were worked into the soil, in form of nitrate of soda, dissolved bone black and muriate of potash, before the following crop was sown. In plots 196 and 197 stable manure was added after each crop. All other plots received no fertilizer after the first crop was planted. 100 grams of carbonate of lime were added to each plot containing soil of coal ashes and moss peat.

The following tables show the fertilizers used and the crops harvested:

TABLE XIII.—RADISH CULTURES IN COAL ASHES AND MOSS PEAT.

Fertilizers applied.	Fertilizer replaced after each crop.				Fertilizer not replaced.							
	Sub-irrigation.		Surface irrigation.				Planted between rows.				Seed unsorted.	No peat in soil.
	Plot 186.	Plot 187.	Plot 188.	Plot 189.	Plot 190.	Plot 191.	Plot 192.	Plot 193.	Plot 194.	Plot 195.	Plot 198.*	Plot 199.
Nitrate of Soda, grams	185.31	276.19	185.31	276.19	185.31	276.19	185.31	276.19	185.31	185.31	276.19	276.19
Nitrogen, "	26.1	38.9	26.1	38.9	26.1	38.9	26.1	38.9	26.1	26.1	38.9	38.9
Dissolved Bone Black, "	67.75	67.75	67.75	67.75	67.75	67.75	67.75	67.75	135 5	203.24	67.75	67.75
Phosphoric Acid, "	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	26.4	39.6	13.2	13.2
Muriate of Potash, "	95.46	95.46	95.46	95.46	95.46	95.46	95.46	95.46	95.46	95.46	95.46	95.46
Potash, "	44.4	44.4	44.4	44.4	44.4	44.4	44.4	44.4	44.4	44.4	44.4	44.4
Yield.												
First Crop.												
Number of radishes	172	177	206	195	186	182	180	188	206	192	206	210
Weight of radishes, grams	1080	1047	1204	1022	1064	962	1006	876	1182	1251	1258	1002
Second Crop.												
Number of radishes	194	193	183	195	191	188	169	179	180	195	188	193
Weight of radishes, grams	1543	1446	1318	1254	1388	1458	737	1047	1309	1385	1154	1215
Third Crop.												
Number of radishes	192	192	191	183	187	173	184	197	187	184	177	189
Weight of radishes, grams	1701	1638	1593	1396	1292	1168	1475	1904	1731	1379	908	617
Total number	558	562	580	573	564	543	533	564	573	571	571	592
Total weight	4324	4126	4115	3572	3744	3588	3218	3827	4222	4015	3320	2834
Fourth Crop.												
Number of radishes	....	....	....	....	....	....	196	188	....	....	....	....
Weight of radishes, grams	....	....	....	....	....	....	1071	1312	....	....	....	....

* In second and third crops French Breakfast radishes were grown.

TABLE XIV.—RADISH CULTURES IN COMPOST.

	Stable Manure added after each crop.		Seeded between rows. Manure not replaced.	
	Plot 196.	Plot 197.	Plot 200.	Plot 201.
Yield.				
First Crop.				
Number of radishes	172	173	167	186
Weight of radishes, grams	971	1016	939	1119
Second Crop.				
Number of radishes	173	189	153	173
Weight of radishes, grams	1566	1595	1011	1003
Third Crop.				
Number of radishes	167	145	175	173
Weight of radishes, grams	463	837	1390	1773
Total number	512	507	495	532
Total weight	3000	3418	3340	3895
Fourth Crop.				
Number of radishes	....	....	133	117
Weight of radishes, grams	....	....	391	241

RESULTS.

1. By planting between the rows of the half grown crop, four crops can be obtained in the time required to raise three crops by the usual method of planting.

2. There is very little, if any, advantage in sub-irrigation. In each case, save one, the weights of the crops were slightly greater from the sub-irrigated plots, but there was no perceptible difference in the quality of the radishes.

3. There was no difference in quality and appearance of the radishes grown in compost and in coal ashes and peat, but those grown in the last named soil required one or two weeks less time to reach maturity.

4. The crop grown in coal ashes alone (plot 199) was below the average, both in appearance and yield.

5. French Breakfast proved inferior to Cardinal Globe as a forcing variety.

6. Planting seed selected by sifting out the small seeds (nearly one-third of the whole) made no perceptible difference in either quality or quantity of the crop.

7. Very little difference in yield, weight or time of the maturing of the crop can be ascribed to differences in the quantity of fertilizers used. Good results were obtained by adding to the mixture of coal ashes and peat, for each 100 square feet of bench space—

2.5 pounds of nitrate of soda,
2.4 " " dissolved bone black,
1.4 " " muriate of potash.

This sufficed for three crops of radishes.

The total yield of radishes (3 crops) from all the plots filled with coal ashes and peat was, per 100 square feet of bench space, 388 bunches (10 in a bunch) or 57 pounds (tops included).

The average composition of these radishes was—

Water, lost in air-drying	94.35
Nitrogen	0.240
Phosphoric Acid	0.062
Potash	0.233

According to this year's tests, 1000 bunches of radishes weigh 147 pounds and take from the soil—

5.6 ounces of nitrogen,
1.4 " " phosphoric acid,
5.4 " " potash.

The figures agree quite closely with those given in our Report for 1896, p. 225.

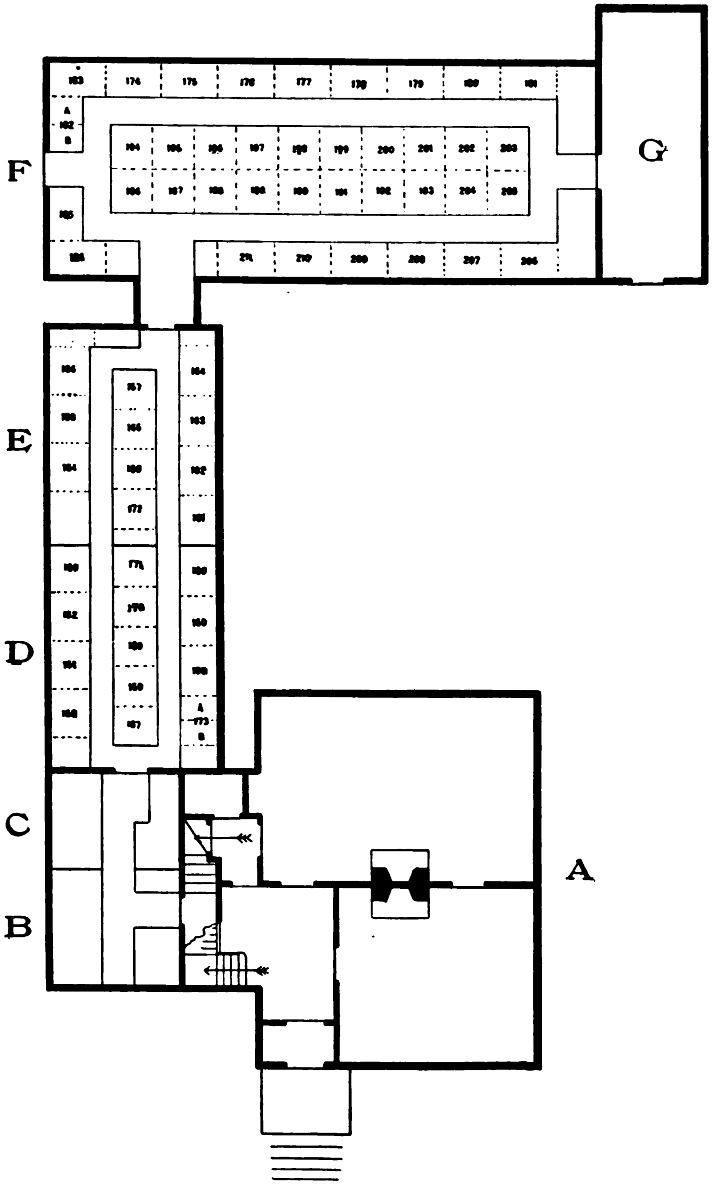

PLATE I. PLAN OF FORCING-HOUSES.

A, Botanical Laboratory; B, C. Small Plant Houses; D, E, Tomato Houses; F, New Forcing-House; G, Work-room.

A STEAM STERILIZER FOR SOILS.

By W. E. Britton.

Eel-worms or nematodes are often a serious pest in field culture and in the forcing houses. They are extremely small, almost microscopic, and are commonly found in the decaying vegetable matter of soils. A few species, including *Trichina*, are, however, animal parasites. They attack the roots of plants, causing abnormal growths or galls on the root system and greatly impairing the vitality of the plant. Atkinson* names thirty-six species of plants including field and garden crops which he found attacked by nematodes in Alabama. The list contains peach, potato, egg-plant, tomato, cotton, watermelon, beet, corn, cabbage, turnip, parsnip and lettuce.

In our own forcing houses they have attacked and damaged tomatoes, lettuce, roses and violets.

To prevent or, at least, mitigate, such attacks, it is a common practice of gardeners to remove the soil from the greenhouse benches and allow it to lie out of doors during the following winter, as the freezing kills many of the nematodes. But the eggs are said to survive the winter and hatch in the following spring, so that this treatment only serves to hold the trouble in check somewhat. The compost used in the Station forcing houses has always been infested with these eel-worms, while plants growing in a soil of coal ashes and peat moss have never suffered from them.

Bailey found† that nematodes could be destroyed by freezing the soil or by applying salt to it, but the latter treatment is quite liable to kill or at least injure the plants which are afterward set in the benches. Lime water and kainit have been recommended at various times and have been applied with some degree of success.

Recently, heating the soil has been advised for the purpose of killing nematodes, which in no stage of development can survive a high temperature. Steaming is probably preferable to baking, as it does not dry up the soil and cannot destroy its organic matter.

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* Ala. Sta. Bull., 9, 1889.

† Bulletin 43, New York (Cornell) Agr. Exp. Station, 1892.

But few devices and methods for steaming soil have been described, and so far as I am aware, no apparatus has been figured. A method of sterilizing soil in large quantities was described briefly by Galloway in American Gardening, Vol. XVIII, 1897, p. 127.

A sterilizer has been designed and made for use in the Station forcing-houses which involved small expense in construction and proved to be convenient to manipulate and efficient. The apparatus, here described, is too small for large establishments, but the principles embodied in its construction would doubtless apply equally well on a large scale.

It consists of a square box made of heavy galvanized sheet-iron connected with the steam-heating system in the potting room of the forcing-house. This box is cubical in form, each of its three dimensions being thirty inches; six inches of the top is in the shape of a removable cover. Steam enters through a hole in the center of one side, to which is soldered a coupling. A three-fourths inch pipe, fitted with a valve, connects the apparatus with the steam-heating system. A few strips of wood placed under the box raise it a half inch from the cement floor, to prevent rusting. Inside the metal box are similar strips upon which the trays rest. Two small holes in the bottom allow the condensed water to escape.

The soil is placed in the trays, which are made of wooden frames having bottoms of galvanized wire netting. The frames are made of strips of wood three and one-half inches wide and seven-eighths of an inch thick; after fastening the netting, a half inch strip is nailed on to hold the netting firmly and to cover its jagged edges. The dimensions of the trays in inches are 27 × 13 × 4 over all, and inside are 25¼ × 11¼ × 3½ inches. The wire netting has six meshes to the inch. Soil is spread loosely and evenly in the trays to the depth of about three inches and the trays packed inside the metal box in cob-house fashion, as shown in plate II, opposite page 312. There is a space of one and one-half inches all around the trays inside the box, and a space of an inch between the two trays. The half inch strips on the bottom edges of the trays allow the steam to enter above and below the soil in each of the trays. As the steam comes in contact with the soil, both above and below it, much less time is required to heat it than when in a solid mass. The sterilizer contains fourteen trays, which, when filled to the depth of three inches, hold 6.9 cubic feet of soil, or enough to fill one of the plots in the new forcing-house. (See plate II, facing this page).

Steam entering through a three-fourths inch pipe, at a pressure of five pounds per square inch, heats the soil to the boiling point of water in about fifty minutes—a great deal depending of course, on the density of the soil—as a loose soil heats through much more rapidly than if packed closely. The box is not steam-tight but nearly so for a low pressure; considerable expense would be necessary to make it perfectly steam tight and at the same time permit of convenience in opening the box.

Soil was kept in the apparatus one hour for the purpose of killing the nematodes. This doubtless destroyed also many fungous germs, but where absolute sterility from bacteria and fungi is desired it would be necessary to steam the soil for a much longer time. The steamed soil is also almost wholly free from live seeds of weeds while the untreated soil was considerably infected with various common weeds.

QUANTITIES OF MINERAL MATTERS AND NITROGEN IN VIOLETS GROWN UNDER GLASS.

By A. L. Winton.

The following analyses were made on material sent to the Station by Mr. W. F. Jost, of East Haven, who asked what ingredients winter grown violets took from the soil, and to what amount.

Four large plants, including the roots, freed from earth as far as possible, and 300 flowers, as picked for market, were separately analyzed with the following results.

Percentage Composition of Violet Plants and Blooms.

	Plants.	Blooms.
Water	75.845	88.052
Organic and Volatile matters	15.382	10.803
Pure ash	2.030§	.910§
Sand, adhering	6.743	.235
	100.000	100.000

§ Including the oxygen equivalent of chlorine.

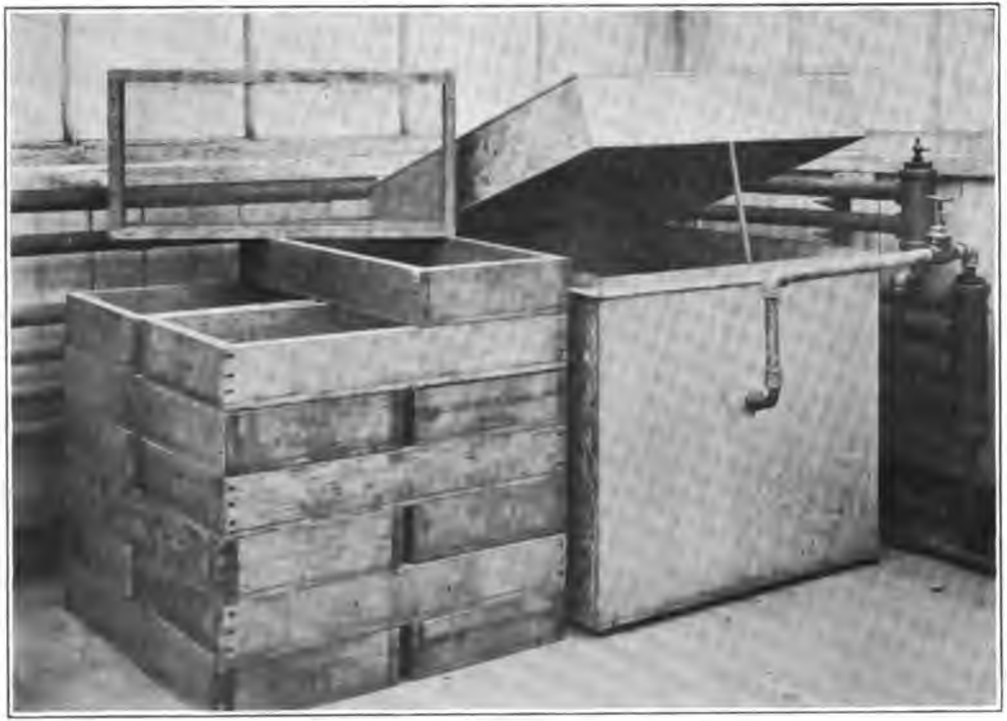

Plate II.—A Steam Sterilizer for Soil.

The Ash contains

	Plants.	Blooms.
Silica	.235	.031
Oxide of Iron	.576	.028
Lime	.182	.075
Magnesia	.075	.070
Potash	.515	.462
Soda	.163	.037
Phosphoric acid	.110	.101
Sulphuric acid	.095	.070
Chlorine	.079	.036
Total	2.030	0.910
The organic matter contains nitrogen	0.454	0.298

Knowing the weight of the plants and blooms, the quantities of the several ingredients contained in them respectively can be calculated as follows :

	One thousand plants contain in pounds.	One hundred thousand blooms contain in pounds.
Water	257	114
Organic and volatile matters	52	14
Other mineral matter	7	1
	316	129

Nitrogen	1.5	.38
Potash	1.74	.60
Soda	.55	.05
Lime	.62	.10
Magnesia	.25	.09
Phosphoric acid	.37	.13
Sulphuric acid	.32	.09
Chlorine	.27	.05
Other matters	2.76	.06
	6.88	1.11

INSECT NOTES OF THE SEASON.

BY W. E. BRITTON.

Apple Curculio injuring Peach twigs.—On June 15th, Mr. E. Rogers submitted to the writer some injured twigs from his peach orchard in Southington. The new growth had been drilled full of small holes, usually in rows, the rows running lengthwise the stem. Small dark-colored beetles were still working upon the twigs; these were identified by the writer as the Apple Curculio (*Anthonomus quadrigibbus*, Say.), and this determination was later confirmed by Mr. E. A. Schwarz of the Department of Agriculture, through the courtesy of Mr. Howard.

The insect is very common upon apples, causing the fruit to be irregular and gnarly with hard lumps and streaks in the flesh.

The adult female deposits an egg just beneath the skin of the apple, in which the young larva feeds for nearly a month. The pupa state is passed within the apple, and lasts two or three weeks, when the beetle emerges.

Infected fruit does not drop, but grows ill-shaped. The insect hibernates in the adult or beetle state.

Mr. Rogers stated that the curculios killed twelve young trees in his orchard by their attacks; the trees were set the previous spring and had made a growth of five or six inches. The owner applied a tobacco decoction to the remaining trees and testifies that it prevented further injury. Spraying with the arsenites usually forestalls any serious damage.

According to Mr. Howard, the species has not before been reported as attacking peach trees.

San José or Pernicious Scale (*Aspidiotus perniciosus*, Comstock).—This insect is now well established in Connecticut, and is probably the worst insect pest known to the fruit growers.

At the time of this writing, the scale has been reported from New London, Groton, Mystic, Hartford, Farmington, New Britain, Plantsville, Meriden, Wallingford, New Haven, Hamden, Woodbridge, Bridgeport, Darien and Greenwich. It will be seen that the scale is well distributed along the coast and up the Connecticut River valley as far as Hartford. Doubtless the species is present in many other localities, where it has not been discovered. Owing to the inconspicuousness of the scale, it is very liable to become well established on trees and shrubs which are not subjected to a thorough and frequent inspection. There are a number of insecticides that will kill the scale, but it cannot be kept in complete control unless these insecticides are applied with great thoroughness and persistence. If only fruit trees and shrubs were attacked, there would be a better chance of controlling the pest, but when our forest and shade trees are once infested there is little hope that the species can be destroyed. We must expect therefore that while an infected orchard may be kept fairly free by the proper treatment, we cannot exterminate the scale unless through the agency of some natural enemy. Since issuing our last annual report, a fungous disease of the San José scale due to *Sphærostilbe coccophila*, Tul. has been reported by Prof. P. H. Rolfs of the Florida Experiment Station.* This fungus is said to occur on three continents, and is probably native to Florida, as it is found on a native scale. Observations of Prof. Rolfs show that artificial cultures of the fungus can be made in the laboratory quickly, and at slight expense, and that its application "cleared the orchards more effectively of San José scale than could have been done by many sprayings." It is not yet known whether *S. coccophila* will survive the winters of the northern and western States, but experiments are now in progress to decide this point.

In New Jersey, spraying with kerosene has given good results, and is now being recommended as a treatment against the pernicious scale. It is necessary however, to observe that the application *must be in the form of a very fine spray* and at a time when the tree or plant is *perfectly dry*. The spraying should be done on a bright day when the kerosene will evaporate rapidly. If these conditions are not observed the trees may be injured and perhaps killed.

Whale-oil soap applied at the rate of two pounds of soap to one gallon of water, is still a good remedy. If used in summer one pound to the gallon will kill all scales that come in contact with the mixture.

The Station is anxious to obtain statistics regarding the distribution and spread of the scale in the State, and will be glad of any information. Where possible such information should be accompanied by specimens, in order that the identity of the insect may be settled beyond question.

Hollyhocks injured by Spilosoma virginica.—During the first half of July, 1897, the leaves of hollyhocks (*Althæa rosea*) growing in this locality were considerably eaten by the larvæ of the "Virgin" or "White Ermine" moth, *Spilosoma virginica*, Fabr. The caterpillar is covered with hairs and is nearly white in color when first hatched, but later becomes yellow and when full-grown is usually of a yellowish-brown color. The color varies greatly however, and it is not uncommon to find larvæ which are cream-colored and others very dark-brown. When young the caterpillars are more or less gregarious, and may be found feeding upon the under sides of the leaves. The caterpillar is sometimes called "The Yellow Bear," and feeds on a great variety of plants. Caged specimens spun cocoons in folded leaves and the adults emerged two weeks later.

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* Bulletin 41, Fla. Exp. Station.

The moth has a wing-expanse of about one and one-half inches, is nearly pure white, with abdomen yellow spotted along either side and upon the dorsum with a row of black dots.

The species is a very common one and can probably be kept in check by hand-picking; if not, the arsenites will prove an effectual remedy.

Plum leaves eaten by the Grape-vine Flea-beetle.—Mr. N. K. Pike, of New Hartford, brought to the Station plum twigs which had been badly eaten by a small steel-blue beetle known as the Grape-vine Flea-beetle, *Haltica* (*Graptodera*) *chalybea*, Illiger. The mischief evidently was done by the adult, though the larvæ are voracious feeders upon grape leaves. The insect lives through the winter in the adult form and eats into the swelling grape buds in early spring. The beetles feed upon the bud and tender foliage for nearly a month, during which time the females lay eggs in clusters upon the under surface of the leaves. The larvæ feed upon the leaves for about four weeks, then become pupæ and the adults emerge four weeks later. The larvæ are small and of a dark-brown color. This beetle, though commonly feeding upon the grape, has several food-plants including the plum and elm.

Jarring is sometimes practiced as a remedial measure, but two applications of Paris green or arsenate of lead, one when the buds are first attacked, and the second when the young larvæ appear, are all that is necessary to control the pest upon the grape. Other plants should be sprayed at any time when injured by the beetles.

A Maple Insect.—Specimens were received during the summer from several different localities, of maple leaves infested with plant-lice having a peculiar appearance. The insects were determined by Mr. Howard as *Pemphigus acerifolii*, Riley. They are covered with a gray cottony excretion which gives them a resemblance to the woolly aphis of the apple. They are found upon the under side of the leaves, causing them to curl and finally wither. An abundance of "honey dew" exudes from the insects.

The reports coming from different parts of the State show that the species was not local in its attack. It was also observed by the writer in New Hampshire during the latter part of August. Small trees may be kept free by occasional applications of kerosene emulsion, or whale-oil soap, but large ones are much more difficult to treat. It is not probable, however, that any considerable injury will result to shade trees by this parasite.

A Lily Stalk-borer.—Early in July attention was called to a stalk-borer of the common white hardy lily of gardens (*L. candidum*). The attack was serious and in some gardens more than half the plants were affected. The attack was noticed at the time when the plants were in bud and the flower stalks had very nearly reached their full length. Castings were seen about the base of the plant and upon some of the lower leaves. An examination of the stem revealed the presence of a round hole having a diameter of about three-sixteenths of an inch. This hole was usually situated about one-third the distance from the ground to the flower-buds, though it was occasionally found at various heights upon the stalk. Many of these stalks were broken over by the wind. Some turned yellow and withered without breaking. Inside each stalk was a larva about an inch in length which may be described briefly as follows: Color tawny or light-brown; head and anal extremity shiny and slightly reddish; head as broad as abdomen; white dorsal stripe extending full length with broader lateral white stripes extending from middle of seventh segment to posterior extremity. Two black or dark-brown spots or tubercles on each segment, one on either side of dorsal stripe; two brown bars on last segment, bisected by dorsal stripe. Spiracles black or dark-brown. First segment light-brown and shiny, like head. Lateral white stripes cover second segment and extend over a portion of the third. Legs dark-brown and shiny. Four pairs of white pro-legs beside anal pro-legs. Pro-legs occur on 6th, 7th, 8th and 9th segments. Ventral surface white or light-yellow like dorsal stripe; 4th, 5th and 6th segments are brown on ventral side. Larva not hairy.

A larva in captivity ate out the pith the entire length of a lily stem one foot long. An attempt was made to rear the adult, but captured specimens died before pupating. The larva answers very closely the description of the larva of the "Stalk-borer," *Gortyna nitela*, Guenee, and is presumably that species, which is known to attack a variety of plants including potato, tomato, corn, dahlia, aster, cocklebur, etc.

Insects infesting stored grain.—Early in October a sample of rye grain was received from Guilford, which had been stored in bins for several months, and was infested with two distinct species of insects. The saw-toothed grain beetle (*Silvanus surinamensis*, Linn.) was very abundant in the sample, and in addition were found a few specimens of a large light-colored lepidopterous larva about three-quarters of an inch in length. Specimens were sent to the Department of Agriculture and Mr. F. H. Chittenden identified the larva as that of the meal snout moth (*Pyralis farinalis*, Linn.).

S. surinamensis is a small slender beetle about one-tenth of an inch in length. The thorax is furnished with teeth, resembling saw-teeth, of which there are six on each side. There are longitudinal grooves upon the dorsal surface of the thorax. The beetle is brown in color.

The adult of *P. farinalis* is a pretty brown moth having a wing-expanse of three-fourths of an inch, with markings of white and various shades of brown. Both of these insects are extremely common in stored grain, but may be destroyed by enclosing the grain in a tight box and placing inside the box a shallow dish of carbon bisulphide. This substance is extremely volatile and the fumes permeate the bin of grain and kill any animal life there may be in it, without injuring the grain. Care should be taken in using carbon bisulphide, as it is very inflammable and an explosion might occur if fire in any form were taken into the room.

The carbon bisulphide treatment (1 lb. carbon bisulphide to 100 bu. grain) was advised in the case at Guilford, and the owner reports that the treatment was successful.

The Gypsy-moth Scare.—About the middle of August, reports went the rounds of the daily press that Gypsy-moth larvæ had been found in Hartford by Mr. T. S. Frisbee. Upon visiting the locality it was learned that a brood of about twenty larvæ, which Mr. Frisbee supposed to be caterpillars of the dreaded Gypsy moth, *Ocneria dispar* L., had been devouring the foliage of a plum tree in his garden. Mr. Frisbee destroyed them at once, so that no specimens remained for identification.

As these caterpillars were not examined by an entomologist, it is not unlikely that they were the larvæ of some common species and not the one imported from Europe which is causing such devastation in Massachusetts. However, I would warn everyone to be on the lookout, for the insect may be brought into this State in spite of the very thorough measures which are being taken to prevent its spread.

Plant-lice.—Plant-lice were extremely abundant on all kinds of plants during the early summer. This may perhaps be accounted for by the cool and moist weather which prevailed, keeping in check the natural enemies of the plant parasites. These conditions also were favorable to the production of a succulent and tender growth of all vegetation, so that the food-supply of plant-lice was practically unlimited.

The insects were much less abundant during the latter part of the season. It is a well-known fact among entomologists that plant-lice disappear in hot weather, and according to Mr. Ashmead,* they are scarce in the tropics.

Plant-lice are sucking insects and therefore cannot be destroyed by Paris green or other arsenical poisons. They are killed by suffocation or by contact with some of the external poisons like kerosene emulsion, whale-oil soap, or tobacco decoction. Whale-oil soap (one pound dissolved in five gallons of water) is a cheap and efficient remedy, or where plants can easily be covered, as in a greenhouse, plant-lice are killed by the fumes of burning tobacco.

ANALYSES OF FEEDS.

The following feeds have been sent to the Station by purchasers and analyzed by Messrs. Winton, Ogden and Mitchell.

10155. "Chaff," sent by A. N. Farnham, New Haven.

8039. Oat Feed, bought in car-lots by the Norfield Grange for the use of the members. Sent by Horace Hurlburtt, Weston.

6523. Oat Feed. Made by the American Cereal Co. Price $13.00 per ton in sacks. Sent by Horace Burr, Winchester Center. This sample contained wheat middlings.

8995. "Oatena." Sent by P. C. Patterson, Torrington.

6524. Corn and Oats. Made by the American Cereal Co.

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* Proc. 9th Annual Meeting of the Ass. of Economic Entomologists.

Price $13.00 per ton in sacks. Sent by Horace Burr, Winchester Center. This sample also contains wheat middlings.

6665. Corn Meal. Sold by Daniels Mills Co., Hartford. Sampled and sent by O. P. Hills, Silver Lane. Price $14.00 per ton.

6506. Corn Germ Meal. Made by the Oil Seed Pressing Co., N. Y.

6055. Gluten Feed, **6056** Dry Glen Cove Starch Feed, and **6080** "Mixed Feed," all sold by R. G. Davis, New Haven. Sampled and sent by G. C. Bradley, Fair Haven.

10177. Hay of the Flat Pea, *Lathyrus sylvestris*, sent by P. H. Woodford, Avon.

ANALYSES OF FEEDS.

	10155	8039	6523	8995	6524	6625	6506	6055	6056	6080	10177
Water	7.41	6.52	8 30	7.12	10.44	11.69	10.50	5.40	8.05	7.71	10.25
Ash	10.02	6.00	4.38	4.75	3.71	1.33	3.59	1.09	1 09	3.17	4.32
Protein	7.75	6.88	10.19	8.75	9.50	10.19	19.81	20.94	19 87	16 56	26.84
Fiber	24.95	24.63	11.01	16.19	10.54	1.40	8.00	6.73	7.18	7.13	26.51
Nitrogen free extr.	47.52	53.02	62 32	59.16	62.34	71.11	45.11	56.58	51.96	57 61	28.27
Fat	2.35	2.95	3.79	4.03	3.47	4.28	12.99	9.26	11.85	7.82	3.81
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Of the four preparations of oats, none contain as much nitrogenous matter or fat as ground oats, and all contain more fiber or woody matter. All these "Oat Feeds" appear to be waste products containing much chaff and are of inferior value as additions to the coarse fodder of the ration.

Sample **10155,** sold as "chaff," contains more nitrogenous matter, though less nitrogen-free extract than one of the samples of "Oat Feed."

Sample **6524,** "Corn and Oats," contains less nitrogenous matter and more fiber than either whole corn or whole oats of average quality.

Regarding the sample of hay made from the flat pea, Mr. Woodford writes as follows :—

"I send you to-day by express a bag of hay made from the flat pea (*Lathyrus sylvestris*) for analysis. I have been experimenting with the leguminous plants for some years, including flat pea."

"I procured my seed from the Experiment Station at Svalöf, Sweden. In May, 1895, I planted the seed in rows about 12 inches apart, putting the seed about 2 inches apart in the row."

"The plants were kept clean from weeds the first season with a wheel-hoe and hand weeding. The roots made a growth of from 12 in. to 36 in. in depth; the tops about 8 in."

"In the spring of 1896 I transplanted about half of the plants in the following manner: I plowed a deep furrow, then placed the plants against the bank, 4 in. apart, then plowed another furrow against them, etc., until the piece was finished. Afterwards the piece was smoothed over with a garden rake."

"The part of the piece that I did not transplant I let go to seed, from which I gathered enough to sow about ⅞ of an acre, last spring. After the flat pea had gone to seed, I cut it for hay."

"This last season from the seed patch and the piece that I transplanted (about ¼ acre), I obtained from two cuttings about 1 ton of hay, a part of which I have sent you for analysis. This season I shall have about 1⅛ acres of this plant and I presume that I can cut it three times, if the weather is favorable."

This hay has about the usual composition of hay made from the flat pea. The analysis shows it to be a very concentrated feed and the further progress of Mr. Woodford's experiment will be watched with interest.

ANALYSES OF MILK.

The following analyses were made by the Station chemists on samples sent by Mr. Thomas J. Stroud of Shaker Station.

Each sample represents the carefully mixed morning's and night's milk from six cows taken on the last day of a two weeks' feeding period.

The feed of the cows, per head, during the first and third periods was as follows:—

In the morning, one bushel of cut corn fodder and hay, about 12 pounds, wetted, and two quarts of a mixture of equal weights of wheat bran and cotton seed meal. Later in the morning about six pounds of good hay.

At 4 P. M. one bushel basket of corn ensilage, about 40 pounds, and two quarts of the mixture of bran and cotton seed meal as above.

In the second and fourth periods, the rations were the same as those just named except that instead of two quarts of the bran and cotton seed meal mixture, were fed three quarts of a mixture of equal weights of wheat bran and Cleveland linseed meal.

The analyses of the milk are as follows :—

	Cotton Seed Meal in Ration.		Linseed Meal in Ration.	
	1st Period.	3d Period.	2d Period.	4th Period.
Specific gravity at 60° F.	1.0327	1.0325	1.0324	1 0316
Ash	0.62	0.83	0.71	0.73
Fat	4.40	4.40	4.10	4.00
Casein	3.50	3.56	3.47	3.37
Sugar by difference	5.20	4.86	4.95	5.07
Total solids	13.72	13.65	13.23	13.17
Water	86.28	86.35	86.77	86 83
	100.00	100.00	100.00	100.00

The most marked differences shown by these analyses are that the samples of milk taken while the cows were on the linseed meal ration contained somewhat less fat (0.3 per cent.), and more water (by about 0.5 per cent.), than the samples taken while the cows were in the other ration. The percentages of fat in the solids of the samples taken during the first and third periods (cotton seed meal) are 32.07 and 32.24; the percentages in the second and fourth periods (linseed meal) are 30.99 and 30.37.

ANALYSES OF BUTTER.

In June, 1896, the Dairy Division of the U. S. Department of Agriculture imported packages of the best butters that could be found in the London Market. These were shipped by fast steamer, stored in the ship's dairy refrigerator, and on their arrival in New York were examined, June 28th, by William H. Healy, official butter inspector of the New York Mercantile Exchange, and graded according to their quality.

Through the courtesy of Major Henry E. Alvord, Chief of the Division, samples of these butters were supplied to this Station and were examined at the Station by some of our creamery officials. In the following table are given analyses of these samples and of two samples from the Vernon (Conn.) Creamery Co., one of them, **8810**, stated to represent butter ordered for export by Major Alvord. There is also given the score of each sample, fixed by Mr. Healy, as well as the score of two samples of American butter examined at the same time, "Conway Creamery," from the Conway Coöperative Creamery, Conway, Mass., five pound box, made June 11th, 1897, and "Minnesota Star Lake Creamery," from a sixty pound tub, made June 5th, 1897, by Star Lake Creamery, Strout, Minnesota.

The descriptions of the samples are as follows:

A. Made in Dorsetshire, England. Cask of 38 lbs. Bought in London, June 17; arrived in New York June 26.

B. From Denmark. Cask of "Royal Dane," 66 lbs. Bought in London, June 18; arrived in New York June 26.

C. From Normandy in France. Cask of 58 lbs. Bought in London June 17; arrived in New York June 26.

D. From "Rosebud" Creamery, New South Wales. Cubical box of 56 lbs. Bought in London June 17; arrived in New York June 26.

E. From Brittany in France. Box of 12 fresh (unsalted) rolls of 2 lbs each. Bought in London June 18; arrived in New York June 26.

F. From Ireland. Creamery box of 28 lbs. Bought in London June 18; arrived in New York June 26.

8741 and **8810.** Made by Vernon Creamery Co., and sent by the Creamery Co. **8810** represents the butter ordered for export.

ANALYSES OF BUTTER.

	A. Dorsetshire.	B. Denmark.	C. Normandy.	D. Australia.	E. Brittany.	F. Ireland	Vernon Creamery Connecticut. 8741	8810
Water	12 51	8.93	10.17	14.94	15.52	15.02	9.46	10.90
Curd	.68	1.03	1.09	.96	.57	1.53	0.92	1.00
Salt	1.16	.99	2.79	2.22	.11	4.24	5.61	2.42
Fat	85.65	89.05	85.95	81.88	83.80	79.21	84.01	85.68
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The samples C, D, E and F gave a decided reaction for boric acid, probably present in the form of borax.

The samples were scored as follows:

Sample.	Flavor, 40.	Grain, 30.	Color, 15.	Salt, 10.	Package 5.	Total, 100.
Minnesota Star Lake Creamery	36 5	30	15	10	5	96.5
Mass. Conway Creamery......	35	29	15	10	5	94
A, English Dorset	30.5	29	15	9.5	5	89
B, "Royal Dane"............	35	30	15	10	5	95
C, Normandy................	31	29	15	10	5	90
D, New South Wales..........	29	29	15	10	5	88
E, Fresh Brittany Rolls.......	36.5	30	15	10	5	96.5
F, Irish Creamery	26	28.5	14.5	10	5	84

LEGUMIN AND OTHER PROTEIDS OF THE PEA, LENTIL, HORSE BEAN AND VETCH.

By Thomas B. Osborne and George F. Campbell.

In a paper on the Proteids of the Pea and Vetch* the legumin obtained from these seeds was described and some account was also given of other accompanying proteids. Further study has furnished much additional information concerning these substances and made necessary a review of our former work on the pea and vetch.

On investigating the proteid constituents of the horse bean and lentil we found that by repeated fractional precipitations, the globulin from these seeds was separated into fractions, on the one hand wholly free from coagulable matter and on the other consisting of substance which was substantially all coagulable. The former we found to be legumin, in all respects like that described by us from the vetch, and the latter to be a new proteid of different composition and properties, to which we have given the name *vicilin* since we first recognized its presence in the horse bean (*vicia faba*).

This discovery led us to reinvestigate the proteids of the pea and we thus found* that the legumin of that seed, as formerly described by us, was contaminated with more or less vicilin and that when the latter is completely separated, the differences noted in our former paper between the legumin of the pea and that of the vetch disappear and preparations from these two seeds are identical in composition and reactions.

Leguminous seeds mostly contain about 1.2 per cent. of alkali and 1.0 per cent. of phosphoric acid, while in seeds of the cereals 0.5 and 0.7 per cent. of these substances respectively are present.

Liebig and Rochleder as well as Ritthausen attributed the presence of much legumin in the aqueous extracts of leguminous seeds to the basic alkali phosphates. But the water extracts are strongly acid to litmus and accordingly must contain acid phosphates.

We find that a mixture of hydrogen potassium phosphate with enough phosphoric acid to be distinctly acid to litmus, but strongly alkaline to lacmoid, freely dissolves legumin to solutions that behave in all respects like the aqueous extracts of these seeds. Such solutions are unlike those obtained with neutral salts, not being easily precipitated by dilution unless holding a very large proportion of proteid. They yield precipitates with acetic acid which are wholly soluble in sodium chloride brine, thus resembling solutions in sodium bicarbonate.

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* Report of this Station for 1895, p. 262.

In this paper we give first, the results of our investigation upon each seed, and in conclusion a general summary of the properties and composition of the different proteids which we have found.

PROTEIDS OF THE PEA.

Finely ground meal of garden peas was prepared in the laboratory almost entirely free from the outer coating of the seed. Immediately after grinding 1,800 grams were treated with a large quantity of ten per cent. salt solution, strained through fine bolting cloth and, after standing three hours to deposit insoluble matter, the turbid extract was syphoned off and saturated with ammonium sulphate. The precipitate was filtered out, suspended in a little water and dialyzed for eighteen hours. A large part of the ammonium sulphate was thus removed and the proteid dissolved by the dilute saline solution which remained. This solution was filtered perfectly clear through a thick felt of paper pulp and dialyzed for four days. A large precipitate resulted from which, after settling, the solution, **A**, was decanted and treated as described on page 329; the precipitate was dissolved in about 1500^{cc} of ten per cent. brine, the solution filtered clear and made exactly neutral to litmus paper by the cautious addition of 75^{cc} of two-tenths per cent. potash water. The solution was then dialyzed for forty hours, whereby globulin separated out in well defined spheroids which, after settling, united to a coherent mass exactly like vetch legumin, and differing from our previously described pea legumin that had formerly been obtained as a pulverulent precipitate. A portion of this precipitate was washed thoroughly with water and with alcohol and dried over sulphuric acid, giving 16.83 grams of preparation **32**, which had, after drying at 110°, the following composition:

GLOBULIN, **32***.

Carbon	51.87
Hydrogen	7.01
Nitrogen	17.69
Sulphur	0.40
Oxygen	23.03
	100 00
Ash	0.62

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* To avoid confusion and facilitate reference the preparations described in this paper are numbered consecutively with those given in the paper on "Legumin and other Proteids of the Pea and Vetch." Report of this Station for 1895.

This preparation, unlike those made from unneutralized solutions, was almost free from substances insoluble in salt solution. Dissolved in ten per cent. brine and heated above 90° turbidity was produced, which at 98°-100° developed slowly into a considerable coagulum.

During the washing of this preparation considerable substance dissolved in water, yielding a solution which was perfectly neutral to litmus (indicating the absence of acid globulin), and which on adding a little salt, gave a precipitate that with more salt dissolved completely to a solution coagulable by heating.

The remainder of the proteid, of which **32** was a part, was dissolved by adding 50^{cc} of ten per cent. salt solution and the resulting liquid was diluted with water until it contained about 1.25 per cent. of salt. A large part of the proteid was thus thrown down and settled out as a viscid layer, from which after an hour the supernatant fluid was almost completely decanted. This deposit, **X**, was then washed with 200^{cc} of water, which caused it to become opaque and pasty. The wash water, after decanting, was added to the solution from which the proteid had separated, and thereupon another precipitate, **Y**, resulted, from which, after settling, the solution was decanted and dialyzed, thereby yielding precipitate **Z**.

As precipitate **X** was found to give a decided turbidity on heating its solution in a boiling water-bath, it was dissolved by adding ten grams of sodium chloride and water enough to make a final volume of 350^{cc}. The clear solution which resulted, containing about three per cent. of salt, was diluted with water until it contained about one and three-fourths per cent. of salt. A large precipitate, **I**, separated, which rapidly settled as a viscid, semifluid layer from which the solution **II** was soon completely decanted. As the precipitate **I** when dissolved in salt solution still gave a slight turbidity on heating to 99°, it was washed with water, dissolved in 100^{cc} of ten per cent. salt solution and reprecipitated by diluting the resulting clear liquid with 900^{cc} of water. The precipitate which separated was now found to be wholly free from any coagulable matter, for not the slightest turbidity was produced in its solutions in brine even by prolonged heating in a boiling water-bath. The substance was therefore washed thoroughly with water and with alcohol and dried over sulphuric acid, thus giving 12.33 grams of preparation **33**, which had, when dried at 110°, the following composition:

LEGUMIN, 33.

Carbon	51.74
Hydrogen	6.90
Nitrogen	18.04
Sulphur	0.42
Oxygen	22.90
	100.00
Ash	0.78

The solution decanted from **33** was dialyzed free from chlorides and a precipitate obtained which when washed and dried in the usual manner weighed 4.44 grams and had the composition shown by the following figures:

GLOBULIN, 34.

Carbon	52.06
Hydrogen	6.99
Nitrogen	17.86
Sulphur	0.36
Oxygen	22.73
	100.00
Ash	0.32

Solution **II**, page 326, was next diluted with an equal volume of water until it contained about nine-tenths per cent. of salt; after standing a short time the solution was decanted and the fluid precipitate washed thoroughly with water and alcohol and dried, giving 6.47 grams of preparation **35**.

GLOBULIN, 35.

Carbon	51.95
Hydrogen	6.96
Nitrogen	17.76
Sulphur	0.42
Oxygen	22.91
	100.00
Ash	0.57

The filtrate from **35** was dialyzed free from chlorides and yielded 5.18 grams of preparation **36**, which after the usual treatment gave on analysis the following results:

GLOBULIN, **36.**

Carbon	52.43
Hydrogen	7.04
Nitrogen	17.45
Sulphur	0.23
Oxygen	22.85
	100.00
Ash	0.40

Preparations Y and Z obtained as successive precipitates from the solution decanted from **X,** as described on page 326, were separately washed with water and alcohol and dried over sulphuric acid, giving respectively preparation **37,** weighing 8.06 grams, and preparation **38,** weighing 6.80 grams. These had the composition given below:

GLOBULIN.

	37	**38**
Carbon	52.08	52.20
Hydrogen	6.90	7.01
Nitrogen	17.65	17.53
Sulphur	0.28	0.15
Oxygen	23.09	23.11
	100.00	100.00
Ash	0.75	0.46

The solution, described on page 325, that had been decanted from the mixed globulin and after forty hours dialysis had yielded the preparations **32–38,** was further dialyzed for four days and 11.2 grams of globulin obtained having, when dried at 110°, the following composition :

GLOBULIN, **39.**

Carbon	52.45
Hydrogen	7.04
Nitrogen	17.22
Sulphur	0.16
Oxygen	23.13
	100.00
Ash	0.18

It will be noticed that by this extensive fractional precipitation of the pea globulin a separation was effected which yielded legumin, agreeing in reactions with that of the vetch as formerly described and with that of the lentil and horse bean, as will be shown later in this paper, and vicilin, a more soluble globulin of somewhat different composition, which is coagulated by heating its solutions to about 95° and has a very remarkably low content of sulphur. The composition of vicilin is shown by the analyses **36, 38** and **39,** which represent the most soluble globulin contained in the solutions from which they were separated.

VICILIN.

	36	**38**	**39**
Carbon	52.43	52.20	52.45
Hydrogen	7.04	7.01	7.04
Nitrogen	17.45	17.53	17.22
Sulphur	0 23	0.15	0.16
Oxygen	22.85	23.11	23.13
	100.00	100.00	100.00

The reactions of legumin and vicilin will be given fully after describing the preparation of these proteids from other legumes.

On page 325 we described how, after dialyzing for four days the solution of the precipitate obtained by saturating the seed extract with ammonium sulphate, the greater part of the globulin was precipitated and stated that the solution filtered from this globulin, there marked **A,** was reserved for further notice. This solution, which by dialysis had become bulky, was saturated with ammonium sulphate and the precipitate produced, filtered out, suspended in a little water and dialyzed over night. In this way the proteids were concentrated in a small volume of liquid. This solution was then filtered clear and dialyzed. After five days the precipitate which had separated was filtered out and extracted with 10 per cent. salt solution, but as only very little dissolved, it was washed free from chlorides with water, then with alcohol and dried at 110°. Analysis showed it to have the following composition:

LEGUMELIN, **40.**

Carbon	52.93
Hydrogen	7.10
Nitrogen	16.18
Sulphur	0.85
Oxygen	22.94
	100.00
Ash	0.22

The filtrate from **40** was then saturated with ammonium sulphate and the precipitate produced, dissolved in as small a volume of water as possible, filtered clear and dialyzed seven days. A very slight precipitate separated which was filtered out, washed thoroughly with water and found to dissolve in ten per cent. brine, giving a solution which yielded a flocculent coagulum at 53°, the heat coagulation point of the body we designate *legumelin*. The solution from which this small precipitate had separated, after filtering, was heated in a water-bath to 67° and a large coagulum produced which was washed thoroughly with hot water and then with alcohol and dried over sulphuric acid, giving 18 grams of **41**.

The filtrate from **41** was heated to 95° and the resulting coagulum, washed and dried, formed preparation **42**, weighing 4.10 grams. Dried at 110° these gave the following results when analyzed:

LEGUMELIN.

	41	42
Carbon	53.24	53.36
Hydrogen	6.99	6.98
Nitrogen	16.15	16.24
Sulphur	1.09	1.01
Oxygen	22.53	22.41
	100.00	100.00
Ash	0.21	0.21

Another extract, obtained in substantially the same manner as that just described, after removing most of the globulin by dialysis, was saturated with ammonium sulphate and the precipitate produced was dissolved in a little water and its solution dialyzed for seven days, giving a precipitate which was filtered out and found to consist almost wholly of proteid matter insoluble in salt solution. After extracting with brine, this substance was thoroughly washed with water and dried, giving 4.24 grams of preparation **43**. The filtrate from **43** was dialyzed in pipe water for five days longer, but as no more precipitate resulted, it was dialyzed for five days in a large volume of distilled water, which was frequently changed and kept cool by adding ice containing only an extremely small quantity of mineral matter. No precipitate was thus separated, and to the solution was then added ten per cent. of sodium chloride and acetic acid as long as a precipitate formed. The resulting precipitate was filtered out, dissolved in water and sodium carbonate added to very slight alkaline reaction. This caused a large precipitate which when prepared for analysis weighed 5.73 grams, preparation **44**. The solution filtered from this neutralization precipitate contained only a very little proteid, as shown by saturating the filtrate with ammonium sulphate.

The filtrate from the precipitate produced by acetic acid in the ten per cent. salt solution was unchanged on further addition of acetic acid and was therefore saturated with sodium chloride, which gave a second precipitate. This was filtered out, dissolved in water, the solution filtered clear and dialyzed. After chlorides had diffused away the solution was perfectly neutral to litmus and quite clear. It was accordingly concentrated by dialysis in alcohol and the precipitated proteid, **45**, dehydrated by absolute alcohol, and dried, weighed 5.87 grams. These preparations were analyzed with the following results:—

LEGUMELIN.

	43	44	45
Carbon	53.03	53.43	53.23
Hydrogen	7.10	7.01	6.91
Nitrogen	16.30	16.50	16.08
Sulphur	1.01	1.16	1.11
Oxygen	22.56	21.90	22.67
	100.00	100.00	100.00
Ash	0.35	0.80	0.56

It will soon be shown that the proteose of the pea is precipitated by acetic acid, from a solution saturated with sodium chloride, and it might be expected that **45** would therefore contain a large proportion of proteose; but as it was found that this preparation through washing with alcohol and drying at 110° had become insoluble in water, it is probable that the proteose had mostly diffused away during the long dialysis to which the solutions had been subjected.

If the last six analyses are compared, it will be seen that they are in close agreement except **40**, in which carbon and sulphur are somewhat lower, due, we think, to the presence of a little vicilin which might be expected to be present, owing to the method of preparation. To facilitate comparison the other five analyses are arranged in the following table together with those of **5** and **8** described on pages 269 and 271 of our former paper.

LEGUMELIN.

	5	8	41	42	43	44	45	Aver.
Carbon	53.33	53.54	53.24	53.36	53.03	53.43	53.23	53.31
Hydrogen	6.98	6.99	6.99	6.98	7.10	7.01	6.91	6.99
Nitrogen	16.14	16.69	16.15	16.24	16.30	16.50	16.08	16.30
Sulphur	1.00	1.01	1.09	1.01	1.01	1.16	1.11	1.06
Oxygen	22.55	21.77	22.53	22.41	22.56	21.90	22.75	22.34
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

5 and **8**, coagulated by alcohol.
41, coagulated by heat at 67°.
42, coagulated by heat at 95°.
43, coagulated by dialysis in water.
44, precipitated by acetic acid from ten per cent. salt solution.
45, precipitated by acetic acid from saturated salt solution.

The properties and reactions of legumelin will be discussed later after describing its occurrence in other seeds.

Returning to the first extract; the filtrate from **42** contained nothing coagulable on boiling. It was therefore dialyzed in alcohol and so concentrated to small volume. A quantity of proteid was thus precipitated which was filtered out and washed with absolute alcohol. The substance thus obtained, weighing 10.5 grams after drying over sulphuric acid, was dissolved in 100^{cc} of water, with which it gave a clear solution, and sodium chloride was added to saturation, which caused a slight precipitate. This was filtered out, but owing to its small amount was not further examined. The filtered solution was then treated with salt-saturated acetic acid as long as a precipitate was produced, which required a relatively large amount of acid. The resulting gummy precipitate was washed with saturated salt solution, dissolved in water, the solution neutralized with a little sodium carbonate and dialyzed till free from chlorides, when the dialyzer was transferred to alcohol and the solution concentrated to small volume. The substance thus precipitated was filtered out, extracted thoroughly with absolute alcohol and dried over sulphuric acid, giving 4.06 grams of preparation **46**, having when dried at 110°, the composition here given.

PROTEOSE, 46.

Carbon	50.24
Hydrogen	6.96
Nitrogen	17.35
Sulphur	1.25
Oxygen	24.40
	100.00
Ash	0.92

The solution, filtered from **46**, which had been thrown down by the addition of acetic acid to the solution saturated with salt, was neutralized with sodium carbonate, of which a large quantity was required, showing that only a small proportion of the acid had been precipitated with the proteose. This neutralized solution was dialyzed in water until free from chlorides and then concentrated by dialysis in alcohol. The substance thus precipitated was filtered out, washed with absolute alcohol, dried and found to weigh 1.76 grams. This, dried at 110°, gave the following results when analyzed:

PROTEOSE, **47**.

Carbon	49.66
Hydrogen	6.78
Nitrogen	16.57
Sulphur	1.40
Oxygen	25.59
	100.00
Ash	3.20

Preparations **46** and **47** give precipitates with copper sulphate which yield the usual rose-red biuret reaction on adding potash. With nitric acid they give no precipitates but yield yellow solutions on warming. If the solution is first saturated with salt, **46** gives a heavy precipitate with nitric acid which largely dissolves on heating and reprecipitates on cooling, while **47** under like conditions gives only a turbidity diminished by adding an excess of acid.

We have then in the pea the following proteids:

Legumin, a globulin not coagulated by heating its solutions.

LEGUMIN.

Carbon	51.74*
Hydrogen	6.90
Nitrogen	18.04
Sulphur	0.42
Oxygen	22.90
	100.00

---

* This figure for carbon is about 0.4 per cent. lower than that given in our former paper, a difference which we attribute to the fact that this preparation, **33**, was made from a neutralized solution and that vicilin had been separated from it completely.

Vicilin, a globulin soluble in a more dilute brine than legumin, coagulated on heating its solutions to 95°–100° and having the following composition:

VICILIN.	
Carbon	52.36
Hydrogen	7.03
Nitrogen	17.40
Sulphur	0.18
Oxygen	23.03
	100.00

Legumelin, a proteid partially precipitated by dialysis, generally in a coagulated state, the greater part however remaining in solution even after prolonged dialysis. Whether it should be called a globulin or an albumin is perhaps questionable, but its relations seem to be closer to the albumins than to the globulins. Its composition as shown by the average of the analyses of five preparations obtained by three different methods, is:

LEGUMELIN.	
Carbon	53.31
Hydrogen	6.99
Nitrogen	16.29
Sulphur	1.06
Oxygen	22.35
	100.00

A *Protoproteose* precipitated by acetic acid from its solution saturated with salt:

PROTOPROTEOSE.	
Carbon	50.24
Hydrogen	6.76
Nitrogen	17.35
Sulphur	1.25
Oxygen	24.40
	100.00

A *Deuteroproteose* not precipitated by acetic acid from the salt saturated solution:

DEUTEROPROTEOSE.	
Carbon	49.66
Hydrogen	6.78
Nitrogen	16.57
Sulphur	1.40
Oxygen	25.59
	100.00

The combined amount of legumin and vicilin which we have obtained by dialyzing extracts of the pea was about ten per cent., as the following experiments show.

Of the finely ground pea meal, 200 grams were treated with one liter of water, the mixture poured on a coarse sieve and the lumps broken up and washed through with another liter of water. After standing over night, in a cool place, protected with thymol, the suspended matters settled leaving a somewhat turbid solution, of which 1500^{cc} were syphoned off and filtered on a pulp filter. The first 300^{cc} which passed through the filter were rejected, as they were mixed with the water contained in the pulp. The next, liter of clear solution, was dialyzed until all that could be thus precipitated had separated in the form of minute spheroids. In this way there was obtained a quantity of proteid which weighed 4.35 grams when washed with alcohol and dried over sulphuric acid. The extract from which this was separated was one-half the total and therefore corresponded quite nearly to that yielded by 100 grams of meal, thus showing that 4.35 per cent. thereof was extracted by distilled water and precipitated by dialysis.

The meal residue (from which, as described, three-fourths of the extract had been syphoned), together with the still adhering one-fourth of the extract, was treated with ten per cent. salt solution until the volume was 2000^{cc}. After settling, the solution was syphoned off, filtered perfectly clear, and dialyzed until all the globulin was precipitated. In this way 9.83 grams of globulin were obtained. As the meal residue before this extraction contained one-fourth of the water extract there should have been present 2.18 grams of proteid soluble in water and precipitable by dialysis. As three-fourths of the total salt extract yielded the above 9.83 grams there should be deducted therefrom three-fourths of 2.18 grams or 1.64 grams, making 8.19 grams of globulin obtained from three-fourths of 200 grams of meal or 5.46 per cent. which added to 4.35 per cent. makes 9.81 per cent. total globulin.

To another lot of 100 grams of meal 500^{cc} of water were added, containing just enough baryta to produce an extract reacting neutral to litmus and to this 500^{cc} of ten per cent. salt solution were added. From 750^{cc} of this extract filtered clear, 7.33 grams of globulin separated on dialysis, equal to 9.77 per cent. of the meal. In another experiment, carried out in essentially the same manner, 10.0 per cent. of globulin was obtained.

By treating the residual meal with alkali but very little more proteid was dissolved. On digesting pea meal with ten times its weight of $\frac{1}{10}$ per cent. soda solution a gelatinous mass resulted from which no clear extract could be obtained. If however a baryta solution of equal molecular strength was used the extract was readily filtered. From such an extract, filtered perfectly clear, there was obtained by adding acetic acid in slight excess 10.56 per cent. of proteid and by dialyzing the filtrate therefrom 3.16 per cent. more. Whether this 13.72 per cent. of proteid was substantially all legumin and vicilin we have no means of knowing. In the first of these experiments it will be noticed that 4.35 per cent. of globulin was obtained by dialyzing the aqueous extract. As the water used in this extraction weighed ten times as much as the meal the saline solution resulting from the mineral constituents of the seed would be so exceedingly dilute as to make it seem doubtful that so much globulin could be thereby dissolved. The reactions of this extract were therefore studied with a view to determine if possible the cause of the solution of the proteid.

When the extract was cautiously poured into distilled water a faint cloud formed at the point of contact of the two liquids which wholly disappeared on shaking. Under similar conditions a globulin solution commonly gives a permanent turbidity. Sodium chloride carefully and very gradually added, beginning with a minute quantity, gave no trace of a precipitate until the solution was saturated with the salt, when a very little proteid separated. A little acetic acid gave a precipitate completely dissolving on adding sodium chloride. If however a somewhat greater quantity of acid was added the precipitate did not wholly dissolve. By cautiously adding very dilute sodium carbonate solution even up to strong alkaline reaction no trace of a precipitate was observed.

Baryta solution when added in considerable quantity gave a little precipitate, probably due to phosphates. Calcium chloride gave a slight precipitate soluble in an excess of calcium or sodium chlorides. Calcium sulphate gave no precipitate.

From this it will be seen that solution of the globulin is apparently not due to the presence of acids, for neutralization gives not even a turbidity, nor to the presence of neutral salts since dilution does not give a permanent precipitate.

An extraction, with water containing just enough baryta to leave the solution neutral to litmus, was made exactly like that last described. This gave 3.75 per cent. of globulin on dialysis as against 4.35 per cent. extracted with water alone. By heating the filtrate from the above mentioned preparation to 85° and washing and drying the coagulum, the amount of legumelin was found to be 2.03 per cent. of the meal.

PROTEIDS OF THE LENTIL.

The proteid substance of the lentil was first observed by Einhof in 1806 (Gehlen's Jour. der Chem. **6,** 543). Liebig (Ann. d. Chem. u. Pharm. **39,** 138), stated that plant-casein is obtained from beans, lentils and peas. Dumas and Cahours (Jour. f. prakt. Chem. **28,** 398), extracted lentils with warm water, allowed the extract to deposit suspended impurities and precipitated the proteid from the decanted solution by adding acetic acid. After washing the substance thus separated, with water and alcohol and drying it, they obtained the following figures by analysis:

Carbon	50.46
Hydrogen	6.65
Nitrogen	18.19
Oxygen, etc.	24.70
	100.00

Ritthausen (Die Eiweisskörper, etc. Bonn, 1872) described a single preparation of proteid from this seed, obtained in nearly the same way as the preceding, for which he gave the following composition:

Carbon	52.53
Hydrogen	6.84
Nitrogen	16.49
Sulphur	0.40
Oxygen	23.74
	100.00

For our work, coarsely ground lentils were freed almost completely from the outer seed coats by a current of air and were then ground to a fine flour. Two kilograms of this flour were treated with ten liters of ten per cent. sodium chloride solution and after a short time the extract was strained out on fine bolting cloth and allowed to stand over night in a cold place to deposit the suspended starch. The partly clarified extract was then passed through a centrifugal separator and finally filtered perfectly clear through a thick bed of filter paper pulp. The extract was saturated with ammonium sulphate, the precipitate produced dissolved in dilute brine, the solution filtered perfectly clear and dialyzed for three days.

The globulin that had separated on dialysis was filtered out and after washing with water and alcohol, dried over sulphuric acid. Preparation **48** was thus obtained, which weighed 170.0 grams.

The solution from which **48** had separated was dialyzed for six days longer, when it was filtered from a very small precipitate which, when washed and dried formed preparation **49**, that weighed 2.12 grms. The filtrate from **49** was saturated with ammonium sulphate, the separated proteid filtered out, dissolved in water, the solution filtered clear and dialyzed. After prolonged dialysis but a trace of substance separated, which was filtered out, and the clear solution dialyzed in alcohol until all the proteid was precipitated. The substance thus obtained after drying weighed 6.78 grams. It was ground fine, exhausted with water and washed with alcohol, forming preparation **50**.

These preparations were dried at 110° to constant weight and analyzed with the following results:

	48	**49**	**50**
Carbon	51.59	52.12	53.31
Hydrogen	6.99	6.88	6.71
Nitrogen	17.63	16.21	16.08
Sulphur	0.56	0.79	0.97
Oxygen	23.23	24.00	22.93
	100.00	100.00	100.00
Ash	0.49	0.79	0.74
Amount	170.0 grams	2.12 grams	6.78 grams.

In order to subject **48** to fractional precipitation one hundred grams were treated with 250^{cc} of water and 250^{cc} of ten per cent. brine added. A large part failed to dissolve, having been converted into an insoluble form during the process of separation. This part was collected on filters, washed with cold five per cent. brine, and then with hot brine of the same strength, the cold and hot washings being kept separate. The residue was next washed with water and with alcohol and dried, giving 62.23 grams of preparation **51**. The washings made with hot brine were diluted with four volumes of water so as to form a one per cent. salt solution and the precipitate produced allowed to settle, when the solution was decanted and the deposit washed with water and alcohol and dried, yielding preparation **52**, weighing 3.28 grams.

The solution filtered from **51**, which measured 300cc, was mixed with the cold washings, and diluted until the solution contained two per cent. of salt. The rapidly settling precipitate which separated was washed with water and with alcohol, and when dry weighed 4.75 grams, preparation **53**.

The solution decanted from **53** was treated with an equal volume of water making a one per cent. brine, whereby substance was separated which, when washed and dried in the usual way, gave 9.5 grams of preparation **54**.

The filtrate from **54** was cooled during the night to about 5°, which caused a further deposit, that by the usual treatment gave 7.69 grams of preparation **55**.

So large a proportion of **48** had become insoluble in salt solution, that it was thought best to make another lot of the globulin, which if possible should be more soluble. Accordingly 1000 grams of lentil flour were extracted with ten per cent. brine and the globulin separated by dialysis in exactly the same way as employed in making **48**. Instead, however, of washing the substance on the filter with alcohol it was removed from the paper, re-dissolved in five per cent. brine, and the filters washed with the same solution. The filtrate and washings measured 800cc. As 600cc of five per cent. brine had been used this solution contained 30 grams of salt. To this was added 1000cc of water, so that the resulting mixture contained 1.66 per cent. of sodium chloride and had a temperature of 25°. The large precipitate that appeared, soon settled to a coherent layer on the bottom of the jar, so that the solution, very nearly clear, could be decanted almost completely. The deposit was thoroughly washed with water and with alcohol, and after drying weighed 21.43 grams, preparation **56**.

The solution decanted from **56** was cooled over night to 5°. The proteid separated as a dense semi-transparent deposit which on washing with water became opaque and white. It was then dehydrated with absolute alcohol and dried, giving 16.10 grams of preparation **57**.

The filtrate from **57** was dialyzed for four days whereby chlorides were completely separated. A coherent layer of globulin, which was deposited on the bottom of the parchment bag, when washed and dried, weighed 32.8 grams and formed preparation **58**.

These preparations were dried to constant weight and analyzed with the following results:

GLOBULIN.

	51	52	53	54	55	56	57	58
Carbon	51.52	51.43	51.44	51.62	52.13	51.53	51.39	52.05
Hydrogen	6.96	6 91	6.96	7.01	7.19	6.86	6.98	7.02
Nitrogen	17.69	18.02	17.99	17.87	17.47	18.06	18.03	17.29
Sulphur	0 50	23 64	0.44	0.46	0.23	0.49	0.44	0.21
Oxygen	23.33		23.17	23.04	22.98	23.06	23.16	23.43
	100.00	100.00	100.00	100.00	100.00	100 00	100.00	100.00
Ash	0.94	0.61	1.43	0.33	0.29	0.61	0.14	0.08

In this seed, as in the pea, we thus found that by fractional precipitation, the globulin is separated into two parts which differ in composition and solubility. As however, none of the less soluble fractions was wholly free from coagulable matter, another extraction was made in which the acid of the seed was neutralized and the fractional precipitations were repeated until products entirely free from coagulable proteid were obtained.

Accordingly 2000 grams of meal were treated with ten liters of ten per cent. salt solution in which had been dissolved sufficient potash to yield an extract neutral to litmus, as determined by a preliminary trial. After thoroughly mixing, the whole was allowed to stand over night, with thymol, in a cool place, when the partly cleared extract was syphoned off and filtered. The solution was then saturated with ammonium sulphate, the precipitate was filtered out, suspended in water and dialyzed over night. The proteid thus dissolved, the solution was filtered perfectly clear and dialyzed in two parts. Part I, which was obtained first, was treated as follows:

After dialyzing four days the precipitated globulin was filtered out and the filtrate, A, treated as subsequently described. The precipitate was dissolved in 500^{cc} of two per cent. salt solution and 500^{cc} of water added. A large precipitate formed, from which, after settling, the solution, B, was decanted.

The precipitate was then dissolved in 400^{cc} of two per cent. salt solution and precipitated again by adding 400^{cc} of water. The solution, C, was decanted from the precipitate thus thrown down, the latter was dissolved in five per cent. salt solution, and found to yield a considerable coagulum on heating in a boiling water-bath, showing it to still contain some vicilin. The latter solution was filtered clear and dialyzed for three days, when the precipitate which had formed was dissolved in 300^{cc} of two per cent. salt solution, and 100^{cc} of water added, causing a large precipitate which was found to be entirely free from coagulable matter. After washing this with water and alcohol, and drying over sulphuric acid, 23.67 grams of preparation **59** were obtained having the following composition when dried at 110°:

LEGUMIN, **59.**

Carbon	51.80
Hydrogen	6.86
Nitrogen	18.09
Sulphur	0.42
Oxygen	22.83
	100.00
Ash	0.29

The solution decanted from **59** was treated with 200^{cc} of water and the precipitate produced allowed to settle. The solution was then decanted and the precipitate washed with water and alcohol giving 5.36 grams of preparation **60,** which when dried at 110° and analyzed gave the following results:

GLOBULIN, **60.**

Carbon	51.83
Hydrogen	7.01
Nitrogen	17.75
Sulphur	0.29
Oxygen	23.12
	100.00
Ash	0.46

The solution decanted from **60** was dialyzed free from chlorides and the precipitate thereby separated, after washing and drying as usual, gave preparation **61,** which analysis showed to contain:

VICILIN, **61.**

Carbon	52.13
Hydrogen	6.95
Nitrogen	17.40
Sulphur	0.22
Oxygen	23.30
	100.00
Ash	0 21

Solution B, page 340, was diluted with an equal volume of water which caused a precipitate, from which, after settling, the solution was filtered. The deposit was washed, dried and analyzed with the following results:

VICILIN, 62.

Carbon	52.28
Hydrogen	7.02
Nitrogen	17.41
Sulphur	0.08
Oxygen	23.21
	100 00
Ash	0.21

The filtrate from this preparation was saturated with ammonium sulphate, but very little proteid was found in it.

Solution C, page 340, was also treated with an equal volume of water which precipitated a further quantity of globulin, that when dried weighed 5.55 grams, and had the following composition:

VICILIN, 63.

Carbon	52.14
Hydrogen	7.02
Nitrogen	17.27
Sulphur	0.18
Oxygen	23.39
	100.00
Ash	0.21

Solution A, described on page 340, from which the greater part of the globulin extracted from the meal had been removed by dialysis, was saturated with ammonium sulphate. The precipitate produced was suspended in water and dialyzed over night, thereby bringing the proteid into solution in a comparatively small volume of water. This solution was then filtered perfectly clear, and dialyzed forty hours, when a considerable precipitate separated which was filtered out, washed, dried and analyzed with results as follows:

VICILIN, 64.

Carbon	52.03
Hydrogen	6.91
Nitrogen	17.60
Sulphur	0.13
Oxygen	23.33
	100.00
Ash	0.26

The filtrate from **64**, after uniting with the similar solution from part II of this extract, was further dialyzed for nine days, until free from sulphates, when the precipitate which had formed was filtered out, washed, dried and analyzed ; It weighed only 1.13 gram and had the following composition :

LEGUMELIN, **65**.

Carbon	53.02
Hydrogen	——
Nitrogen	16.36
Sulphur Oxygen	——
Ash	0.47

The clear solution filtered from **65** was then heated in a water-bath for three hours at 65° and the resulting coagulum filtered out and the filtrate further heated to 82°, whereby a second coagulum was produced. These two preparations, **66** and **67** respectively, were washed with hot water and with absolute alcohol and gave on analysis when dried at 110° the following results:

LEGUMELIN.

	66	**67**
Carbon	53.33	53.23
Hydrogen	6.87	6.88
Nitrogen	16.28	16.35
Sulphur	0.85	1.00
Oxygen	22.67	22.54
	100.00	100.00
Ash	0.20	0.41

The filtrate from **67** was concentrated by dialysis in alcohol and the proteid so precipitated filtered out, washed with absolute alcohol and redissolved in a little water. This solution was dialyzed and found wholly free from globulin, and also from coagulable proteid. The solution was then precipitated by pouring into much alcohol and the substance so separated dried and analyzed.

PROTEOSE, **68**.

Carbon	50.17
Hydrogen	6.77
Nitrogen	16.81
Sulphur	1.27
Oxygen	24.98
	100.00
Ash	1.03

As already stated, the solution of the first ammonium sulphate precipitate of the proteids contained in the original extract was divided into two parts, which were dialyzed separately. The precipitate so produced in part **II** was dissolved in 500^{cc} of two per cent. brine and 750^{cc} of water added, giving an abundant precipitate, which was washed with water and alcohol and dried over sulphuric acid. This preparation, **69,** wholly free from coagulable proteid, weighed 19.0 grams and had when dried at 110° the following composition:

LEGUMIN, **69.**

Carbon	51.91
Hydrogen	7.11
Nitrogen	17.91
Sulphur	0.38
Oxygen	22.69
	100.00
Ash	0.62

In order to further fractionate preparations **59** and **69,** quantities of each were mixed together, dissolved in five per cent. salt solution and filtered from a very small amount of insoluble matter. That any acid possibly present in combination with this globulin might be neutralized, three-tenths per cent. potash solution was cautiously added until the solution reacted just perceptibly alkaline with litmus paper. This solution was then dialyzed over night and the precipitate which separated was filtered out and the filtrate dialyzed twenty-four hours longer, giving a second precipitate, which was washed and dried as usual, forming preparation **70,** while the first dialytic precipitate was redissolved in ten per cent. brine, filtered perfectly clear and again dialyzed over night. The precipitate which separated was prepared for analysis in the usual manner and formed preparation **71.** These two products were found to be free from coagulable matter and to have the following composition, which is essentially the same as that of the preparations from which they originated:

LEGUMIN.

	70	71
Carbon	51.85	51.74
Hydrogen	6.88	6.87
Nitrogen	18.07	18.09
Sulphur	0.37	0.39
Oxygen	22.83	22.91
	100.00	100.00
Ash	0.56	0.44

Since legumin has been described as soluble in water, 400 grams of lentil meal were twice treated with two liters of water, and strained on bolting cloth. The extract was allowed to settle over night, and the somewhat turbid liquid (four liters) was syphoned off and saturated with ammonium sulphate. The precipitated proteids were treated with dilute brine, in which nearly all dissolved. The solution was filtered clear and dialyzed for forty-eight hours; the resulting precipitate, weighing, when dried, 7 grams, was analyzed with the following results:

LEGUMIN, 72.

Carbon	51.65
Hydrogen	6.90
Nitrogen	18.05
Sulphur	0.38
Oxygen	23.02
	100.00
Ash	0.64

One more extraction was made in the following manner. To 1200 grams of lentil meal, six liters of water were added which held in solution 6.21 grams of baryta, the amount which had previously been determined to yield an extract neutral to litmus. After thoroughly mixing with the meal and breaking up all the lumps, six liters of ten per cent. salt solution were added. Unlike extracts not neutralized or neutralized with soda or potash, the insoluble matter in this case formed large flocculent masses which rapidly settled. The insoluble matter was strained out on bolting cloth and the nearly clear extract was saturated with ammonium sulphate. The proteid thus separated was filtered out, dissolved in water and dialyzed for three days. The greater part of the globulin was thus separated. It was filtered out and the filtrate was treated as described on page 346. The precipitate was dissolved in two per cent. brine and diluted until the solution contained 1.25 per cent. of salt. After depositing the resulting precipitate the solution was decanted and the precipitate was five successive times redissolved in 50^{cc} of ten per cent. brine and thrown down by diluting to 400^{cc} with water. The final precipitate, which was free from coagulable globulin, was washed with water and alcohol and dried. It weighed 15.85 grams and had the following composition:

LEGUMIN, **73.**

Carbon	51.63
Hydrogen	6.95
Nitrogen	18.00
Sulphur	0.43
Oxygen	22.99
	100.00
Ash	0.33

The solutions, resulting from the five just mentioned precipitations, and containing about one per cent. of salt, were diluted with an equal volume of water, forming a one-half per cent. salt solution. Proteid was thus precipitated which when dry weighed 20.25 grams, but was not further examined as it was doubtless a mixture of legumin and vicilin. The solution decanted from the foregoing precipitate was dialyzed for four days whereby 9.35 grams of preparation **74** were obtained having the following composition:

VICILIN, **74.**

Carbon	52.15
Hydrogen	6.81
Nitrogen	17.21
Sulphur	0.14
Oxygen	23.69
	100.00
Ash	0.26

The filtrate described on page 345 from which the greater part of the globulin present in the extract had been separated by dialysis, was saturated with ammonium sulphate, the precipitate produced dissolved in a little water, and the solution filtered clear and dialyzed for seven days, when it was filtered from a small precipitate which analysis showed to be probably a mixture of vicilin and legumelin. The solution was returned to the dialyzer and the dialysis continued several days but nothing more separated. The solution was then concentrated by dialysis in alcohol and the precipitated proteid was dehydrated with absolute alcohol and dried. This preparation was then extracted with water, the residue remaining was washed with alcohol, dried at 110° and analyzed, **75.**

Legumelin, 75.

Carbon	53.10
Hydrogen	6.91
Nitrogen	16.16
Sulphur	1.09
Oxygen	22.74
	100.00
Ash	0.56

It is thus evident that the lentil contains the same proteids as the pea, viz: legumin, vicilin, legumelin and proteose.

In the following tables are brought together the analyses of the numerous preparations of these proteids, so that they may be easily compared.

Legumin.

	52	53	54	55	56
Carbon	51.43	51.44	51.62	51.53	51.39
Hydrogen	6.91	6.96	7.01	6.86	6.98
Nitrogen	18.02	17.99	17.87	18.06	18.03
Sulphur	23.64	0.44	0.46	0.49	0.44
Oxygen		23.17	23.04	23.06	23.16
	100.00	100.00	100.00	100.00	100.00

	59	70	71	72	73
Carbon	51.80	51.85	51.74	51.65	51.63
Hydrogen	6.86	6.88	6.87	6.90	6.95
Nitrogen	18.09	18.07	18.09	18.05	18.00
Sulphur	0.42	0.37	0.39	0.38	0.43
Oxygen	22.83	22.83	22.91	23.02	22.99
	100.00	100.00	100 00	100.00	100.00

As the five analyses standing last in the above table were made on preparations obtained from neutralized solutions and free from coagulable proteids, we consider them to represent the composition of lentil legumin most accurately, and accordingly we give the following average of these analyses for the composition of this substance.

Lentil Legumin.

Carbon	51.73
Hydrogen	6.89
Nitrogen	18.06
Sulphur	0.40
Oxygen	22.92
	100.00

VICILIN.

	55	**58**	**61**	**62**	**63**	**64**	**74**	Aver.
Carbon	52.13	52.05	52.13	52.28	52.14	52 03	52.15	52.13
Hydrogen	7.19	7.02	6.95	7.02	7.02	6.91	6.81	6.99
Nitrogen	17.47	17.29	17.40	17.41	17.27	17.60	17.21	17.38
Sulphur	0.23	0.21	0.22	0.08	0.18	0.13	0.14	0.17
Oxygen	22.98	23.43	23.30	23.21	23.39	23.33	23.69	23.33
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

LEGUMELIN.

	50	**65**	**66**	**67**	**75**	Average.
Carbon	53.31	53.02	53.33	53.23	53.10	53.20
Hydrogen	6.71	----	6.87	6.88	6.91	6.82
Nitrogen	16.08	16.36	16.28	16.35	16.16	16.25
Sulphur	0.97	----	0.85	1.00	1.09	0.98
Oxygen	22.93	----	22.67	22.54	22.74	22.75
	100.00	----	100.00	100.00	100.00	100.00

PROTEOSE, **68.**

Carbon	50.17
Hydrogen	6.77
Nitrogen	16.81
Sulphur	1.27
Oxygen	24.98
	100.00

The quantity of proteid extracted by water and precipitated by dialysis was determined for the lentil, as follows:—

To 200 grams of fine ground meal one liter of water was added, the mixture was poured upon a sieve and the lumps broken up by washing them through with another liter of water. After mixing and standing a short time, the coarse residue was strained out on bolting cloth, and the fine suspended matter allowed to settle over night at a low temperature. The solution was then syphoned off, filtered perfectly clear on a pulp filter, the first 300^{cc} containing the water retained in the pulp being rejected, and 1000^{cc} of the clear undiluted extract next passing the filter dialyzed as long as anything precipitated. In this way 9.76 per cent. of proteid was recovered, which contained 17.32 per cent. of nitrogen, showing the substance to be nearly pure globulin.

This operation was repeated with the same quantities and proportions of materials, but with the addition of just enough baryta to the water to give an extract perfectly neutral to litmus. On dialysis 13.72 per cent. of globulin was obtained, a considerably larger quantity than that yielded by the unneutralized extract.

Although the globulins extracted from the lentil by brine are legumin and vicilin, identical in composition and properties with those from the pea, yet the proportion extracted by water from the lentil is much greater, especially when the acid of the seed is neutralized to litmus.

A rigid comparison of the reactions given by the aqueous extracts of the lentil, both acid and neutral, showed no difference whatever and in these reactions the extracts agreed strictly with those similarly obtained from the pea, except that with calcium chloride and sulphate heavy precipitates were obtained, readily soluble in a slight excess of calcium or sodium chloride. Extracts of the pea gave only slight precipitates with calcium chloride and none with calcium sulphate.

PROTEIDS OF THE HORSE BEAN (*Vicia faba*).

The only references which we have found to investigations of the proteids of this seed that at present have any importance, are contained in papers by Ritthausen.*

In his earlier work† Ritthausen described as legumin the proteid extracted from the horse bean by potash water. Later, (Jour. f. prakt. Chem. **26**, 504 and **29**, 448) he gave the results of treating the earlier preparations with salt solution and also of extracting the seeds with brine and precipitating the dissolved proteid by dilution or by acids, and concluded that the preparations which he obtained were mixtures of two proteids which could only be separated by dissolving in acid or alkali, precipitating by neutralization and extracting the precipitate with brine; the part dissolving he regarded as conglutin; that undissolved, as legumin. A careful study of Ritthausen's work leaves us in much doubt respecting the nature of the proteids of this seed, and we have therefore undertaken the present investigation.

In order to avoid contaminating our preparations with tannin, which Ritthausen found to be present in considerable quantity in the skin of these beans, we removed the greater part of the outer coating from the coarsely broken seeds by a current of air and the remainder by hand-picking. In this way it was possible to separate the brown outer seed-coat completely and by then grinding the broken beans to obtain a flour free from tannin.

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* Earlier references to legumin have been already noticed in our paper on Legumin of the Pea and Vetch, Report of this Station for 1895, p. 262.

† Die Eiweisskorper etc., Bonn. 1872, p. 170.

A preliminary extraction made with this flour gave us a large yield of proteid which, in general, had nearly the properties and composition of the products similarly obtained from the pea and lentil, but differed throughout in containing less carbon than the corresponding substances from these other seeds, and in being to a considerable extent soluble in water. As these aqueous solutions reacted strongly acid with litmus and when neutralized gave precipitates soluble in brine which were reprecipitated by dilution, we were led to believe that the differences which we had found between the proteids of this seed and those of the pea, lentil and vetch were due to a combination of the proteids with the acid of the seed. As this view appeared to be confirmed, we omit further details of our first extraction and proceed to an account of the second.

Two kilograms of the bean flour were treated with ten liters of ten per cent. salt solution, protected with thymol, and left over night in a cool place. The extract was strained on fine bolting cloth and allowed to deposit suspended matter during two hours. The turbid liquid was syphoned off, centrifugated and filtered nearly clear. The extract was then saturated with ammonium sulphate, the precipitate produced filtered out, removed from the paper, suspended in a little water and dialyzed for twenty-four hours, whereby so much of the sulphate was removed that the proteid dissolved. The solution so obtained was then filtered perfectly clear through a pulp filter and dialyzed for 44 hours. The precipitate which had formed, at first separated in spheroids, but these on settling united to a coherent mass, **A**, from which the solution, **B**, was decanted.

A portion of the precipitate **A**, weighing 28 grams when air-dry, was washed thoroughly with water (in which it partly dissolved) and then with alcohol and dried at 110° for analysis.

LEGUMIN, 76.

Carbon	51.55
Hydrogen	6.91
Nitrogen	18.12
Sulphur	0.48
Oxygen	22.94
	100.00
Ash	0.54

The remainder of precipitate **A** was dissolved in brine and the resulting solution, having an acid reaction to litmus, was neutralized by adding very dilute potash water. This required 0.36 gram of potassium hydroxide. The slightly turbid solution was filtered absolutely clear and dialyzed for forty-eight hours. The large precipitate which resulted was found to dissolve completely in brine and to yield a perfectly neutral solution, which when heated in a boiling water-bath gave some coagulum. A portion of this precipitate was washed with water and alcohol, dried at 110° and analyzed.

LEGUMIN, 77.

Carbon	51.87
Hydrogen	6.97
Nitrogen	18.05
Sulphur	0.38
Oxygen	22.73
	100.00
Ash	0.84

The remainder of this substance was dissolved in 250^{cc} of three per cent. brine and the solution diluted to 600^{cc}. A rapidly settling precipitate resulted which formed a fluid deposit from which the somewhat turbid mother liquor was soon decanted, the proteid was washed thoroughly with water and alcohol, yielding when dry 19.13 grams of preparation 78.

LEGUMIN, 78.

Carbon	51.79
Hydrogen	7.06
Nitrogen	18.10
Sulphur	0.40
Oxygen	22.65
	100.00
Ash	0.79

The solution decanted from 78 was diluted with 150^{cc} of water and a second precipitate obtained, wholly like the first, which when dried weighed 11 grams and had the following composition:

LEGUMIN, 79.

Carbon	51.90
Hydrogen	6.94
Nitrogen	18.12
Sulphur	0.38
Oxygen	22.66
	100.00
Ash	0.59

The solution from which **79** had separated was further diluted with 500^{cc} of water and let stand over night in a cool room. The next morning the solution was decanted from a small precipitate that had settled out. This after drying weighed 5.00 grams and had the following composition:

LEGUMIN, 80.

Carbon	51.92
Hydrogen	7.04
Nitrogen	18.11
Sulphur	0.30
Oxygen	22.63
	100.00
Ash	0.60

The solution decanted from **80** was dialyzed for four days but only a trace of proteid separated. Preparations **78, 79** and **80** contained no trace of coagulable proteid and may therefore be considered to be pure legumin. Since however, **77**, of which these were fractions, was shown by this treatment to contain only a very little coagulable matter, it too is essentially pure legumin as indicated by the analysis.

Solution B, described on page 350, was further dialyzed for 24 hours and the resulting precipitate, C, filtered out and the filtrate, D, treated as described on page 353.

The precipitate C was dissolved in ten per cent. brine, and the resulting solution diluted until it contained one per cent. of salt. The precipitate that formed was filtered out and the filtrate added to solution D. The precipitate was again dissolved in salt solution, filtered clear, exactly neutralized with dilute potash water and dialyzed for 48 hours.

The globulin which had separated was filtered out. The filtrate contained a little more proteid, which yielded a coagulum on heating in a boiling water-bath.

The globulin was dissolved in 200^{cc} of two per cent. brine, and the solution diluted with 200^{cc} of water, which threw down a precipitate from which the solution, E, was decanted and treated as further described, while the precipitate was redissolved in salt solution, which was then dialyzed for 24 hours.

The precipitate which finally resulted, after washing and drying, weighed 16 grams and when dried at 110° had the following composition:

GLOBULIN, 81.

Carbon	51.89
Hydrogen	7 03
Nitrogen	17.67
Sulphur	0.34
Oxygen	23.07
	100.00
Ash	0.76

The solution filtered from 81 contained but little proteid, which coagulated on heating to 99°.

Solution E, page 352, on diluting with an equal volume of water, gave a precipitate that, when washed and dried, weighed 4.74 grams, having the following composition:

GLOBULIN, 82.

Carbon	52.31
Hydrogen	7.04
Nitrogen	17.70
Sulphur	0.21
Oxygen	22.74
	100.00
Ash	0.57

Solution D, noted on page 352, being inconveniently bulky, was saturated with ammonium sulphate, and the precipitate thus separated was dissolved in a little water, the solution was filtered clear and dialyzed for five days. The deposited substance was filtered out and the filtrate, F, treated as described later. The precipitate was dissolved in brine, the solution obtained was filtered clear and dialyzed for three days whereby all but a trace of the proteid was precipitated. This was filtered out, dissolved in 100^{cc} of two per cent. salt solution and precipitated by adding 50^{cc} of water. After the proteid, thus thrown down, had settled, the supernatant liquid was decanted and 50^{cc} more water added, which caused a second precipitation. The solution from which this had separated was then dialyzed and the globulin contained in it precipitated. Thus three successive fractions were obtained which when washed and dried weighed respectively 5.65, 3.87 and 2.73 grams. When dried at 110° and analyzed these were found to have the following composition:

VICILIN.

	83	84	85
Carbon	52.53	52 53	52.40
Hydrogen	6.93	6.98	7.09
Nitrogen	17.28	17.61	17.54
Sulphur	0.19	0.10	0.13
Oxygen	23.07	22.78	22.84
	100.00	100.00	100.00
Ash	0.26	0.18	0.13

Filtrate F, page 353, from which the substance yielding the three preceding preparations had been derived, was further dialyzed for seven days until freed from sulphates, which caused the separation of a small precipitate that, when filtered out, washed and dried, weighed 1.64 grams and gave the following results on analysis:

PROTEID, 86.

Carbon	52.43
Hydrogen	6.87
Nitrogen	16.42
Sulphur Oxygen	24.28
	100.00
Ash	0.28

The filtrate from 86 was then heated to just 60° for about two hours, which caused a coagulum that was filtered out, washed with hot water and with alcohol, dried and found to weigh 1.60 grams. The filtrate from this coagulum was heated for some time at 75° and a second coagulum obtained, weighing 1.80 grams. Dried at 110° the two preparations had the following composition:

LEGUMELIN.

	87	88
Carbon	52.81	52.98
Hydrogen	6.98	6.89
Nitrogen	16.49	16.43
Sulphur	23.72	1.32
Oxygen		22.38
	100.00	100.00
Ash	0.23	0.23

These two preparations are probably legumelin, although their carbon is distinctly less than that found in our preparations from other leguminous seeds. Since the solution from which these preparations separated had not been previously neutralized, we are inclined to ascribe this difference to an acid combined with the proteid.

The filtrate from 88 was next dialyzed against alcohol until all proteid matter was precipitated. This was filtered out, washed with absolute alcohol, dried and found to weigh 6.78 grams. This preparation was dissolved in a little water, filtered from a slight insoluble residue, the solution was dialyzed for five days, then heated to boiling and filtered from a trace of coagulum. The filtrate, which gave no precipitate on saturating with salt, was then concentrated to small volume over a water-bath and precipitated by pouring into alcohol. In this way 4.45 grams of proteose was obtained, which when dried at 110° and analyzed was found to have the following composition:

PROTEOSE, 89.

Carbon	50.24
Hydrogen	6.66
Nitrogen	17.11
Sulphur	1.87
Oxygen	24.12
	100.00
Ash	0.48

In order to confirm the foregoing results another extraction was made by treating 1200 grams of bean meal with 4200^{cc} of water containing 9.44 grams of baryta, just enough to saturate the acid of the seed, using litmus as an indicator. This amount was ascertained by a careful preliminary test with 100 grams of the meal using an accurately standardized solution of baryta. After thoroughly mixing the meal with the water, an equal volume of ten per cent. brine was added, causing the gummy meal residue to separate in masses which settled quite rapidly and left the solution comparatively clear.

The residue was then strained out on fine bolting cloth and the extract allowed to stand a short time, when it was syphoned from the sediment, filtered nearly clear and saturated with ammonium sulphate. The precipitate produced was filtered out, suspended in water and dialyzed over night. The next morning the solution of the proteid, which had resulted on dialyzing away the greater part of the adherent sulphate, was filtered and dialyzed for four days. A large precipitate of globulin separated which was filtered out and the filtrate, G, was treated as is subsequently described. The precipitate was redissolved in brine, filtered perfectly clear and dialyzed for 42 hours, whereby a large amount of globulin separated in form of spheroids that united on settling to a coherent mass. From this the solution, H, was decanted almost completely. The precipitate was dissolved in 500^{cc} of two per cent. salt solution and the globulin again thrown down by diluting the salt solution to 1.33 per cent. After the large precipitate produced had settled, the solution, I, was decanted and the globulin redissolved in 100^{cc} of ten per cent. brine and precipitated by diluting to 750^{cc}. As the substance still contained some coagulable matter it was four times redissolved in 50^{cc} of ten per cent. brine and precipitated by diluting to 500^{cc}. The final precipitate gave only an opalescence on heating its solution in a boiling water-bath. Washed with water and with alcohol and dried over sulphuric acid, this preparation weighed 41.0 grams and had the following composition when dried at 110°:

LEGUMIN, **90**.

Carbon	51.55
Hydrogen	7.03
Nitrogen	17.95
Sulphur	0.38
Oxygen	23.09
	100.00
Ash	0.15

Solutions G, H, I and those from the four last precipitations of **90** were separately dialyzed and the globulin which deposited was all dissolved together by adding 50^{cc} of ten per cent. brine to water in which the substance was suspended. The resulting solution contained 1.7 per cent. of salt and was diluted to a content of 1.3 per cent. This gave a precipitate on which the same treatment was repeated. The two solutions decanted from these precipitations were united and diluted with 200^{cc} of water, the precipitate was united with the twice precipitated proteid just described and the solution, J, set aside for further treatment. The united precipitates were dissolved with 50^{cc} of ten per cent. salt solution and water added to 400^{cc}. The precipitate produced, which still yielded some opalescence in the boiling water-bath, was washed with water and alcohol and when dried weighed 15.93 grams and had the following composition:

LEGUMIN, 91.

Carbon	51.72
Hydrogen	6.95
Nitrogen	18.00
Sulphur	0.42
Oxygen	22.91
	100.00
Ash	0.18

The solution decanted from **91** was united with solution J, before noticed, and diluted until the salt content was 1.0 per cent. After standing over night, the solution was decanted from the precipitate, which when washed and dried over sulphuric acid, weighed 9.8 grams and when dried at 110° had the following composition:

LEGUMIN, 92.

Carbon	51.70
Hydrogen	7.12
Nitrogen	18.05
Sulphur	0.36
Oxygen	22.77
	100.00
Ash	0.16

The solution decanted from **92** was dialyzed free from chlorides, the precipitate produced dissolved in one per cent. brine and the solution diluted with an equal volume of water. After the proteid which separated had settled out, the solution was decanted and the deposit was washed with water and alcohol. When dry 14.41 grams of proteid were obtained, which was analyzed with the following results:

GLOBULIN, 93.

Carbon	52.14
Hydrogen	7.08
Nitrogen	17.59
Sulphur	0.15
Oxygen	23.04
	100.00
Ash	0.13

By adding a quantity of water to the solution decanted from **93** the globulin remaining in solution was precipitated and gave when dried, 5.80 grams of proteid of the following composition:

VICILIN, 94.

Carbon	52.36
Hydrogen	7.12
Nitrogen	17.43
Sulphur	0.10
Oxygen	22.99
	100.00
Ash	0.10

Solution G, page 356 was saturated with ammonium sulphate and the proteid thereby precipitated was dissolved in water, the solution filtered perfectly clear and dialyzed six days, when the precipitate produced was filtered out, washed and treated as usual, giving preparation **95**, weighing 4.23 grams.

PROTEID, 95.

Carbon	52.21
Hydrogen	7.12
Nitrogen	16.50
Sulphur	1.23
Oxgyen	22.94
	100.00
Ash	0.33

The filtrate from **95** was then heated to 65° in a water-bath, the coagulum was filtered out and the filtrate heated to 85°, which caused a second coagulum. The two preparations, **96** and **97**, were washed with hot water, dehydrated with absolute alcohol, dried and found to weigh 3.47 grams and 1.38 grams respectively.

LEGUMELIN.

	96	97
Carbon	52.68	53.29
Hydrogen	7.14	7.05
Nitrogen	15.96	16.00
Sulphur	1.33	1.24
Oxygen	22.89	22.42
	100.00	100.00
Ash	0.25	0.31

The filtrate from **97** gave no coagulum on boiling and was therefore saturated with salt, but as no precipitate formed, salt saturated acetic acid was added as long as proteid was thereby separated. The resulting precipitate was dissolved in water, filtered clear and dialyzed till free from chlorides. The salt saturated filtrate was neutralized with sodium carbonate and also dialyzed till free from chlorides. Both solutions were next dialyzed in alcohol until concentrated to small volume, then were treated with excess of alcohol and the precipitates obtained were filtered out. That from the salt saturated solution amounted to hardly more than a trace, while that from the acetic acid precipitate, **98**, weighed 4.14 grams:

PROTOPROTEOSE, **98**.

Carbon	49.96
Hydrogen	6.76
Nitrogen	16.95
Sulphur	2.75
Oxygen	23.58
	100.00
Ash	0.28

The large amount of sulphur found in this preparation was confirmed by a second closely agreeing determination. The small quantity of ash and the method of preparation make it impossible that this sulphur could be due to admixture of either calcium sulphate or ammonium sulphate.

In the horse bean, as in the pea and lentil, the proteids soluble in salt solution are legumin, vicilin, legumelin and proteose. In the following tables the analyses of the purer preparations of these proteids may be readily compared.

LEGUMIN.

	76	**77**	**78**	**79**	**80**	**90**	**91**	**92**	Aver.
Carbon	51.55	51.87	51.79	51.90	51.92	51.55	51.47	51.70	51.72
Hydrogen	6.91	6.97	7.06	6.94	7.04	7.03	7.02	7.12	7.01
Nitrogen	18.12	18.05	18.10	18.12	18.11	17.95	18.00	18.05	18.06
Sulphur	0.48	0.38	0.40	0.38	0.30	0.38	0.42	0.36	0.39
Oxygen	22.94	22.73	22.65	22.66	22.63	23.09	23.09	22.77	22.82
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

VICILIN.

	82	83	84	85	93	94	Aver.
Carbon	52 31	52.53	52.53	52.40	52.14	52.36	52.38
Hydrogen	7.04	6.93	6.98	7.09	7.08	7.12	7.04
Nitrogen	17.70	17.28	17.61	17.54	17.59	17.43	17.52
Sulphur	0.21	0.19	0.10	0.13	0.15	0.13	0.15
Oxygen	22.74	23.07	22.78	22 84	23.04	22.99	22.91
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

LEGUMELIN.

	87	88	96	97	Average.
Carbon	52.81	52.98	52.68	53.29	52.94
Hydrogen	6.98	6.98	7.14	7.05	7.02
Nitrogen	16.49	16.43	15.96	16.00	16.22
Sulphur	23.72	1 32	1.33	1.24	1.30
Oxygen		22.38	22.89	22.42	22.52
	100.00	100.00	100.00	100.00	100.00

PROTEOSE.

	89	98
Carbon	50.24	49.96
Hydrogen	6.66	6.76
Nitrogen	17.11	16.95
Sulphur	1.87	2.75
Oxygen	24.12	23.58
	100.00	100.00

In order to determine the amount of the proteids of this seed extracted by water, 200 grams of the fine meal were thoroughly mixed with 2000^{cc} of water so that all lumps were broken up, and the coarse residue was strained out on bolting cloth. After standing two hours, the greater part of the starch, etc., settled and 1400^{cc} of extract were syphoned off and filtered perfectly clear on a pulp filter, the first 300^{cc} being rejected and the next 1000^{cc} collected separately. The latter was dialyzed for four days, in which time all the proteid separable in this way deposited as spheroids. The precipitate, washed and dried, was equal to 16 per cent. of the meal.

The process just described was exactly repeated save that enough baryta was at first added to make the extract neutral to litmus: the yield of proteid was 18 per cent.

The proteid from the first extraction contained 1.16 per cent. of ash and, reckoned ash-free, 17.50 per cent. of nitrogen, showing it to be nearly pure globulin, while that from the second, neutralized extract, was less pure as it contained 5.41 per cent. of ash and contained, ash-free, 16.96 per cent. of nitrogen. The reactions of these extracts were compared under identical conditions with the following result:

Both extracts, like those from the pea, lentil and vetch, when poured into water gave, where the two fluids came in contact, a slight cloud, which disappeared on shaking. Unlike the neutralized extract, as well as unlike both neutral and acid extracts of the other legumes, the unneutralized extract of the horse bean gave a heavy precipitate with sodium chloride, even with perfectly pure salt which we prepared from *pure* soda and *pure* hydrochloric acid and proved to be absolutely neutral. This precipitation of the globulin would indicate the presence of an acid compound, but the extract gave only a very slight precipitate on neutralizing with baryta, probably due to phosphates. The addition of acetic acid gave a large precipitate soluble in dilute brine, as did calcium chloride and calcium sulphate.

PROTEIDS OF THE VETCH.

In order to further fractionate vetch globulin, we treated a quantity of preparation **17*** with 900^{cc} of three per cent. brine and, after filtering out the insoluble residue, we added an equal volume of water to the clear filtrate, and then cooled the mixture to 5°. The precipitate thus caused was washed and dried, forming preparation **99**, and the filtrate was diluted with an equal volume of water which caused a second precipitate, preparation **100.** The residue, insoluble in the three per cent. brine, had become swollen and gelatinous. as has been always observed with the insoluble form of legumin, so that it stopped the pores of the filter. It was therefore washed by decantation with salt solution and finally with water. As the salt was washed out the substance lost its gelatinous properties and became granular and easily filtered. It was next treated with one per cent. sodium carbonate solution, and the small portion insoluble therein was filtered out. The solution was partly neutralized with hydrochloric acid and carbonic acid gas passed through it, which precipitated nearly all the dissolved proteid. This was filtered out, dissolved in brine and the clear solution dialyzed. The substance thus separated, when washed and dried, formed preparation **101.**

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* Annual Report of this Station for 1895, p. 277; also p. 284 but wrongly numbered 16.

These three preparations were carefully analyzed with the following results :

LEGUMIN.

	99	100	101
Carbon	51.72	51.52	51.79
Hydrogen	6.97	6.95	7.03
Nitrogen	18.13	18.08	18.03
Sulphur	0.43	23.47	23.15
Oxygen	22.75		
	100 00	100.00	100.00

Another extraction was made by treating 500 grams of vetch meal with water and then with ten per cent. sodium chloride solution. After filtering clear, the salt extract was saturated with ammonium sulphate, the precipitate produced was dissolved in brine, the solution was filtered perfectly clear and dialyzed. In this way thirty-five grams or 7 per cent. of the meal was obtained as preparation **102**, having the following composition:

LEGUMIN, 102.

Carbon	51.62
Hydrogen	6.92
Nitrogen	17.88
Sulphur	0.50
Oxygen	23.08
	100.00
Ash	0.23

Again, a quantity of vetch meal was digested in saturated salt solution and the dissolved legumin precipitated by dialysis. After drying at 110° this gave the following figures :

LEGUMIN, 103.

Carbon	51.86
Hydrogen	6.99
Nitrogen	17.97
Sulphur	23.18
Oxygen	
	100.00
Ash	0.57

Another extraction was made by treating 1200 grams of meal with three liters of water containing enough baryta to exactly neutralize the acid of the seed when tested with litmus paper. After thoroughly mixing, three liters of ten per cent. salt solution were added and the residual meal strained out on fine bolting cloth. After standing a short time the greater part of the starch settled and the liquid was syphoned off, filtered perfectly clear and saturated with ammonium sulphate. The precipitate produced was filtered out, suspended in water and dialyzed over night, whereupon the proteid dissolved. Its solution was filtered clear and dialyzed for two days with separation of a large precipitate.

This was filtered out and the filtrate, A, examined, as will be described later. The precipitate was dissolved in brine, the solution filtered perfectly clear from a small amount of insoluble matter and dialyzed for two days. The large coherent deposit was washed with water and with alcohol, and dried over sulphuric acid. This preparation, **104,** weighed 75.0 grams and, as it was obtained from nearly three-fourths of the total extract, represented about ten per cent. of the meal. When dried at 110° and analyzed the following results were obtained:

LEGUMIN, **104.**

Carbon	51.59
Hydrogen	7.07
Nitrogen	18 03
Sulphur	0.36
Oxygen	22.95
	100.00
Ash	0.15

The filtrate A was returned to the dialyzer and, after three days, filtered from a small precipitate which, washed and dried, weighed 6.5 grams and gave preparation **105,** having the following composition:

PROTEID, **105.**

Carbon	51.81
Hydrogen	7.10
Nitrogen	17.07
Sulphur	0.57
Oxygen	23.45
	100.00
Ash	0.38

The filtrate from **105** was saturated with ammonium sulphate and the precipitate produced filtered out, dissolved in as small a quantity of water as possible, the solution filtered clear and dialyzed for seven days, when it was filtered from a small precipitate that was partly soluble in salt solution. This was washed with water and alcohol and formed preparation **106**.

The filtrate from **106** was heated to 65° in a large water-bath and a coagulum obtained which when filtered out, washed and dried formed preparation **107**, weighing 3.2 grams. The filtrate from this on heating to 85° gave a small coagulum that, when washed and dried, weighed only 0.88 grams, **108**.

LEGUMELIN.

	106	**107**	**108**
Carbon	53.05	53.33	....
Hydrogen	7.29	6.93	....
Nitrogen	16.25	16.10	16.16
Sulphur	1.19	0.85	....
Oxygen	22.22	22.79	....
	100.00	100.00	....
Ash	0.39	0.26	0.38

The filtrate from **108** gave no coagulum on boiling. It was concentrated, partially by evaporation and further by dialysis in alcohol. A small precipitate thus separated, which was dehydrated with absolute alcohol and dried, giving one gram of preparation **109**, that contained 12.74 per cent. of ash and, reckoned ash-free, 15.71 per cent. of nitrogen.

The results show that the salt extracts of the vetch seed contain no other proteids than legumin, legumelin and a very small proportion of proteose. Vicilin, which was found in the pea, horse bean and lentil, is not present in detectable quantity in the vetch.

Our new analyses of these proteids are tabulated as follows :

LEGUMIN.

	99	**100**	**101**	**102**	**103**	**104**	Aver.	Former Aver.
Carbon	51.72	51.52	51.79	51.62	51.86	51.59	51.69	52.09
Hydrogen	6 97	6.95	7.03	6.92	6.99	7.07	6.99	6.88
Nitrogen	18.13	18.08	18.03	17.88	17.97	18.03	18.02	18.02
Sulphur	0.43	23.45	23.15	0.50	23.18	0.36	0.43	0.46
Oxygen	22.75			23.08		32.95	22.87	22.55
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

LEGUMELIN.

	20	106	107	108	Aver.
Carbon	53.55	53.05	53.33	....	53.31
Hydrogen	6.70	7.29	6.93	....	6.97
Nitrogen	16.46	16.25	16.10	16.16	16.24
Sulphur	1.02	1.19	....	....	1.11
Oxygen	22.27	22.22	....	....	22.37
	100.00	100.00	....	....	100.00

PROTEOSE, 22.

Carbon	50.85
Hydrogen	6.75
Nitrogen	16.65
Sulphur Oxygen	25.75
	100.00

SUMMARY.

As shown in this paper, the pea, lentil, horse bean and vetch contain legumin, legumelin and proteose and the three seeds first named also contain vicilin. A careful comparison of the reactions and properties of these proteids, as now obtained by us, reveals no difference between preparations of the same substance from different seeds.

Legumin.

Legumin forms the chief proteid constituent obtainable from the vetch, pea, lentil and horse bean. In the first named seed about ten per cent. of the meal was found to consist of legumin; in the three other seeds this proteid is associated with vicilin, from which we have no method for its quantitative separation. From the pea, about ten per cent., from the lentil thirteen per cent. and from the horse bean about seventeen per cent. of these mixed proteids were obtained. The lentil contains the least proportion of legumin, which seems to form about two-thirds of the mixed proteids, while the horse bean contains the greatest, as in this seed vicilin is present in relatively small amount.

Legumin is a globulin, for it dissolves readily in saline solutions and is precipitated therefrom either by dialysis, dilution or cooling. By dialysis or by cooling, it separates in the form of spheroids which, after settling from the solution, unite to form a plastic mass. By diluting its concentrated solutions the legumin separates as a viscid translucent fluid. This fluid when treated with water becomes opaque and solid, so that the legumin can be converted into a coarse meal by rubbing with a glass rod under water. Conglutin from lupin seeds and amandin from almonds behave similarly, as do gliadin of wheat and rye and hordein of barley, when precipitated from alcoholic solutions by dilution with water.

Solutions containing more than two per cent. of sodium chloride dissolve legumin abundantly, those containing less salt have a solvent power rapidly decreasing with the diminishing salt content, so that a one per cent. salt solution dissolves very little. Saturation with sodium chloride or magnesium sulphate does not precipitate legumin from its solution in brine, but saturation with sodium sulphate at 34° precipitates it almost completely.

In pure water legumin is entirely insoluble, but if the solution from which the legumin is precipitated contains acid, this may combine with the legumin and the resulting preparation, like other acid globulins, will then dissolve in pure water.

If seeds containing legumin are extracted with water, more or less of the legumin is dissolved; from the pea about 4.0 per cent., from the vetch 2.5 per cent., from the lentil 10.0 per cent., and from the horse bean 16.0 per cent. The legumin thus dissolved is largely precipitated by dialysis in water, by the addition of acids and by lime salts and very slightly by great dilution with water. These aqueous extracts react strongly acid with litmus, and alkaline with lacmoid, a behavior doubtless due to acid potassium phosphates together with organic acids or acid salts, for acids combined with proteids do not react with lacmoid, although they readily turn blue litmus red. Solutions which we have made, of legumin from various seeds as well as of edestin from hemp-seed, by dissolving the proteid in monohydrogen potassium phosphate, have shown us all the reactions of these aqueous extracts excepting one presented by the horse bean, the unneutralized water extracts of which are precipitated with *pure* sodium chloride. This reaction we cannot explain, for these extracts give with dilute acids precipitates soluble in salt solutions and no precipitates on neutralization, reactions which seem to exclude the presence of acid globulin.

Solutions of legumin or of edestin in monohydrogen potassium phosphate behave more like solutions in dilute alkali carbonates than like solutions in neutral salts, for they give precipitates with dilute acids which are soluble in more acid or in salt solutions and are not precipitated by dilution unless very little phosphate is present. If phosphoric acid is added to the potassium phosphate solution, the solvent power of the phosphate is diminished and the facility with which the proteid is precipitated by dilution is increased; but if only little acid is added, yet enough to give a decided reaction with litmus, considerable quantities of the globulins are still dissolved and the reactions of solutions so made closely resemble those of the aqueous extracts of these seeds. As a result of numerous comparisons of the reactions of solutions so prepared with those of the aqueous extracts of leguminous seeds, we believe that the extraction of legumin by water from these seeds is due to the presence of acid potassium salts of phosphoric and organic acids, and that in consequence of the varying proportions of these substances in the different kinds of seeds, different amounts of legumin are thus extracted from them. As the proportion of phosphoric acid to potash in these leguminous seeds is much smaller than in most of the other seeds which we have examined, the character of the salts present may fairly be supposed to differ, and consequently the solubility of the proteids would also differ when the seeds are extracted with water. Thus in lupin seeds the amount of phosphoric acid, 1.4 per cent., exceeds that of the potash, 1.1 per cent., and from them water extracts but little proteid. Liebig and Ritthausen attributed the solubility of legumin to *basic* phosphates, and the latter undertook extensive experiments to show the presence of an excess of potash in the aqueous extracts, but such a supposition appears to overlook the fact that the aqueous extracts of these seeds are decidedly acid towards litmus.

Dissolved in dilute sodium chloride solution, legumin is precipitated by a little acetic acid, the precipitate being soluble in an excess of sodium chloride. The solubility of precipitates so produced depends on the relative proportions of salt and acid.

Legumin extracted without neutralizing the natural acid of the seed and precipitated by dialysis, either directly or after precipitation with ammonium sulphate, is usually converted to a large extent into insoluble "albuminate."

This "albuminate" differs from the similar insoluble products obtained from most other globulins, for when treated with salt solution it becomes gelatinous, cannot be filtered and on washing with water shrinks, becomes opaque and finally granular so that it can be very readily washed on a filter. This substance appears to become hydrated by salt solution and dehydrated by pure water.

If the acid of the seed is previously neutralized, the globulin extracted by salt solution yields very little if any insoluble "albuminate," which indicates that the latter is a product of the action of the acid of the seed. This fact is in harmony with experiments described in a former paper of ours on the action of minute quantities of acid on globulins.* In very dilute acids and alkalies in the absence of salts, legumin dissolves readily and abundantly, to solutions from which, if at once neutralized, it is precipitated in a form soluble in sodium chloride solution. By this treatment no evidence of change has been detected. Solutions made with hydrochloric acid are precipitated by a small excess of acid, but those made with acetic acid are not precipitated by any excess of acid.

Solutions of legumin in ten per cent. sodium chloride brine are not rendered turbid by long heating in a boiling water-bath.

Dissolved in ten per cent. sodium chloride brine, legumin is precipitated by a very little hydrochloric acid, but a relatively considerable amount of acetic acid is required to produce a precipitate in such solutions.

Sodium chloride solutions of legumin give large precipitates with tannic acid as well as with picric acid, those formed by the latter dissolving in an excess of salt solution if too much picric acid had not been previously added. With mercuric chloride no precipitate is produced.

With nitric acid, Millon's and Adamkiewics' tests, proteid reactions are obtained. With the biuret test a violet color is given which on standing becomes a deep rose red like that given by peptones.

Legumin has been supposed by some investigators to contain phosphorus and therefore to belong with the nucleo-proteids. A careful testing of thoroughly purified samples by fusing with caustic soda and nitrate, and treating the solution of the fusion acidified with nitric acid, with ammonium molybdate, showed that in some of the preparations only just detectable traces of phosphorus were present, while other preparations contained none whatever.

Although we have examined large numbers of our preparations of the different plant proteids for phosphorus, we have as yet found none which, in carefully purified samples, contained more than a few hundredths of a per cent. of phosphorus; a quantity so small that it is reasonable to consider it as a constituent of the ever-present ash.

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* Report for 1896, page 369.

The composition of legumin is shown by the following figures, which, except those for the pea, are averages of a number of preparations from each of the different seeds:

LEGUMIN.

	Pea	Lentil.	Horse bean.	Vetch.	Average.
Carbon	51.74	51.73	51.72	51.69	51.72
Hydrogen	6.90	6.89	7.01	6.99	6.95
Nitrogen	18.04	18.06	18.06	18.02	18.04
Sulphur	0.42	0.39	0.39	0.43	0.41
Oxygen	22.90	22.92	22.82	22.87	22.88
	100.00	100.00	100.00	100.00	100.00

Vicilin.

Vicilin is a globulin associated with legumin in the pea, lentil and horse bean. But as we have no means of separating vicilin and legumin quantitatively, we can state nothing respecting the amount in which it occurs in these seeds further than that the lentil contains the most and the horse bean the least. In the lentil it probably forms about one-third of the mixed globulins. That vicilin is not a derivative of legumin is almost conclusively proved by the fact that no vicilin can be obtained from the vetch.

The most remarkable characteristic of vicilin is its content of sulphur, less than that of any other known proteid. This element, it may be noticed, diminishes in quantity with repeated precipitation as though by this process sulphur were split off from the molecule. The total quantity, however, is so small that it might appear unsafe to draw conclusions from the differences observed, that is from 0.23 per cent. maximum to 0.08 per cent. minimum. Yet repeated determinations of this element have shown us that the differences were not analytical. It would seem possible by sufficiently repeated precipitation to obtain from this proteid preparations free from sulphur.

In salt solution, vicilin is much more soluble than legumin, so that by repeated precipitation from diluted solutions the two globulins can be separated.

When solutions of vicilin in ten per cent. brine are heated in a water-bath they become turbid at 90° and at 95° flocks separate. When heated for some time at 100° this globulin is almost completely coagulated. In water vicilin is insoluble. In one per cent. sodium chloride solution it dissolves considerably, while in slightly stronger solutions it is much more soluble, the solution of the globulin appearing to depend on the presence of enough salt to form a soluble compound.

In its other reactions it very closely resembles legumin.

The composition of vicilin we found to be as follows:

VICILIN.

	Pea.	Lentil.	Horse bean.	Average.
Carbon	52.36	52.13	52.38	52.29
Hydrogen	7.03	7.02	7.04	7.03
Nitrogen	17.40	17.38	17.52	17.43
Sulphur	0.18	0.17	0.15	0.17
Oxygen	23.03	23.30	22.91	23.08
	100.00	100.00	100.00	100.00

Legumelin.

We have found legumelin in all the leguminous seeds which we have examined with the exception of the white bean (*Phaseolus vulgaris*) and the blue and yellow lupin.

It is difficult to decide whether this proteid should be considered an albumin or a globulin.

By prolonged dialysis of solutions containing considerable legumelin a very small part separates, usually in a form insoluble in salt solutions. In one case we obtained a precipitate by dialysis which was wholly soluble in brine to a solution from which a relatively large coagulum separated on heating to 65°, thus indicating a globulin. We have found, however, that other proteids, notably edestin, undergo a change in solubility, whereby the proteid becomes gradually more and more difficult to dissolve. Thus edestin changes from a form insoluble in cold brine to one soluble in hot brine, also from one soluble in hot brine to one insoluble therein but soluble in dilute sodium carbonate solution, and finally, from a form insoluble in alkali carbonate to one soluble only in caustic alkali. It is not unreasonable to expect that a proteid which might properly be considered an albumin (i. e. soluble in pure water and coagulable on heating) should undergo a similar change whereby it becomes no longer soluble in pure water but dissolves in salt solutions and then further changes to a form no longer soluble in brine but dissolved by alkali carbonates.

Such a very large proportion of the legumelin resists precipitation by dialysis, that we are inclined to regard the small precipitates which we have obtained in this way as due to changes similar to those which produce so-called "albuminates" from globulins.

In a paper on the proteids of the cow pea we designated this proteid as a globulin, but in view of our subsequent, much more extensive experience, we now consider legumelin to be more properly classed with the albumins.

The amount of legumelin which we have found in the seeds discussed in this paper, was in the pea two per cent., vetch one and one-half per cent., lentil and horse bean one and one-quarter per cent.

No definite coagulation point can be stated for legumelin, for the presence of salts or acids as well as the proportion of dissolved legumelin have a great effect on the temperature at which coagulation takes place. Coagulated legumelin is soluble in very dilute alkalies, as is shown by the following experiment tried with preparation **41** from the pea. About 0.7 gram of this substance which had been nearly dried over sulphuric acid, but which still contained some alcohol, was suspended in 50^{cc} of water and 10^{cc} of 0.5 per cent. caustic soda solution added. The legumelin dissolved at once, giving a glairy solution very similar in appearance to undiluted white of egg. After standing a few moments the viscidity disappeared and the solution became thin and clear. This solution was then almost neutralized by adding a nearly sufficient quantity of a dilute acetic acid which had been previously titrated against the soda solution. The liquid still remained clear and the legumelin was not precipitated until but a trace of the alkali remained unneutralized.

In dilute hydrochloric or acetic acid the coagulum is not soluble. By adding ten per cent. of sodium chloride to solutions containing legumelin, and then acetic acid, the acid compound of this proteid is precipitated, which dissolves in water to a solution that on neutralization gives a precipitate insoluble in water.

By saturating seed extracts, freed as far as possible from all globulin, with sodium chloride or magnesium sulphate only a very slight precipitate is obtained, showing that legumelin is thus slightly if at all precipitated.

Owing to the impossibility of separating legumelin from associated proteose, except in a coagulated state, we have learned but little respecting its reactions.

In the following table we give the average of analyses which we have made of coagulated legumelin from different seeds. These preparations have been obtained in a variety of ways, as can be seen by consulting our papers on the seeds named.

LEGUMELIN.

	Pea.	Lentil.	Horse bean.	Vetch.	Adzuki bean.	Cow Pea.	Soy bean.	Average.
Carbon	53.31	53.22	53.03	53.81	53.97	53.25	53.06	53.31
Hydrogen	6.99	6.82	6.97	6.97	7.01	7.07	6.94	6.97
Nitrogen	16.30	16.27	16.22	16.24	16.31	16.36	16.14	16.26
Sulphur	1.06	0.94	1.30	1.11	0.88	1.11	1.17	1.08
Oxygen	22.34	22.75	22.48	22.37	21.83	22.21	22.69	22.38
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Ritthausen recognized the presence of this proteid in the horse bean and pea, and gave analyses of coagula obtained by boiling extracts of these seeds. These analyses, however, do not agree well with each other and only in a general way with ours. On account of the solubility in alkali of the heat coagulum of this proteid, he did not consider it to be albumin.

Proteose.

As the proteose of these seeds is present in small amount and is difficult to obtain pure, we have not as much information respecting it as is desirable. The pea appears to contain about one per cent., the horse bean about one-half per cent. and the lentil and vetch evidently less. It is probable that more or less of this proteose may be lost by diffusion, for 10.5 grams of what was doubtless nearly pure proteose from the pea, after solution and dialysis yielded only about six grams when reprecipitated. We have obtained a few of the reactions of proteose from the pea and horse bean, but no reactions of this proteid from the lentil and vetch.

By saturation with salt, solutions of the proteose of the pea and horse bean are not precipitated, but by subsequently adding salt saturated acetic acid, a large part of the pea proteose separates while all but a trace of that from the horse bean is thrown down.

Nitric acid in the aqueous solutions of the pea proteose gives no precipitate unless the solution is previously saturated with salt, when a precipitate, soluble on warming and reappearing on cooling, is given by that part of the proteose precipitable by acetic acid from a salt saturated solution, while the part not thus precipitable gives only a turbidity. Both these parts of the pea proteose are precipitated by copper sulphate, and give a rose red biuret reaction.

The composition of the preparations from these seeds was found as follows:

PROTEOSE.

	Pea.		Lentil.	Horse bean.		Vetch.
	46	**47**	**68**	**89**	**98**	**22**
Carbon	50.24	49.66	50.17	50.24	49.96	50.85
Hydrogen	6.76	6.78	6 77	6.66	6.76	6.75
Nitrogen	17.35	16.57	16.81	17.11	16.95	16.65
Sulphur	1.25	1.40	1.27	1.87	2.75	25.75
Oxygen	24.40	25.59	23.98	24.12	23.58	
	100.00	100.00	100.00	100.00	100.00	100.00

46, Precipitated by saturating with salt and adding acetic acid.
47, From the filtrate from **46.**
68, Total proteose precipitated by alcohol.
89, Ditto.
98, Precipitated from salt saturated solution by acetic acid.
22, Total proteose precipitated by alcohol.

If the difficulty encountered in purifying these preparations of proteose and the different methods by which they have been obtained are considered, the agreement between them, except for the sulphur in those from the horse bean, makes it probable that these figures quite nearly represent the composition of this substance.

PROTEIDS OF THE SOY BEAN. (*Glycine hispida.*)

BY THOMAS B. OSBORNE AND GEORGE F. CAMPBELL.

The proteids of the Soy bean, so far as we are informed, have never been the subject of special investigation. The seeds used by us were grown in Kansas and kindly supplied by Prof. C. C. Georgeson. Two varieties have been examined, one known as the yellow soy bean and the other, called in Japan, kiyusuki diadzu.

Yellow Soy Bean.

The seeds were first coarsely ground, then freed almost entirely from the outer coats by a current of air and finally ground to a fine flour.

From this meal, water dissolved a large quantity of proteid, yielding an extract exceedingly difficult to filter and impossible to make perfectly clear, for the solutions, even after repeatedly filtering through the densest filters, were always strongly opalescent.

The aqueous extract reacts acid with litmus, about 0.75 gram of caustic potash being required to produce a neutral reaction in an extract from 100 grams of meal. When thus neutralized no noticeable precipitate is produced, indicating the absence of acid proteid compounds. Dilute acids give abundant precipitates in the aqueous extract, as does the addition of lime salts, the precipitates produced by these reagents being readily soluble in sodium chloride solutions.

Dialysis of the aqueous extract of 100 grams of meal precipitated 16.6 grams of globulin, which was largely soluble in brine. The solution filtered from this precipitate began to coagulate on heating to about 55°; after further heating to 80° the coagulum amounted to 1.53 gram. The reactions of the aqueous extract are like those similarly obtained from other leguminous seeds and indicate that the globulin is dissolved by means of the potassium phosphates contained in the seed.

To obtain the proteids soluble in sodium chloride solution, 2000 grams of meal were treated with ten liters of ten per cent. brine, the extract was strained through fine bolting cloth and the residue squeezed in a screw press. The turbid, gummy extract, measuring about eight liters, was centrifugated until no more solid matter could be removed. The liquid was pumped through a thick bed of filter paper pulp and yielded a reddish yellow solution, which appeared perfectly clear by transmitted light, but was opaque by reflected light. This extract was saturated with ammonium sulphate and a very bulky precipitate obtained which, after draining on filters over night, measured, when removed from the papers, over two liters. This precipitate was stirred up with a little water, strained through bolting cloth to break up lumps, and dialyzed in running water over night. By this process the excess of ammonium sulphate, which had prevented solution, was so far removed that the proteid completely dissolved with the help of the remaining sulphate, in about three liters of water. The liquid was then filtered perfectly clear and again dialyzed for four days. The contents of the dialyzers were then allowed to deposit the large precipitate of globulin that had separated, and from this the solution, A, was syphoned off. The precipitate was collected on several filters, the contents of one were thoroughly washed in succession with water, alcohol, absolute alcohol and ether and dried over sulphuric acid. Preparation **1**, weighing 25.11 grams, was thus obtained. The rest of the globulin was allowed to drain thoroughly on the filters and then dissolved in 750^{cc} of five per cent. brine, yielding 1250^{cc} of solution. To this was added 1000^{cc} of water and the large precipitate produced, after standing about four hours, was filtered out and, without washing, was treated with ten per cent. brine. Nearly all dissolved, but a little slimy substance that remained suspended in the solution, made filtration practically impossible. The solution was therefore passed through the centrifugal separator, which removed a small quantity of viscid matter, and was then filtered perfectly clear through paper pulp and dialyzed for two days. The large precipitate which resulted was filtered out and washed with water. The washings at first were clear, but afterwards became turbid in consequence of the precipitation of dissolving proteid. The substance was then washed with dilute alcohol and finally with absolute alcohol and dried over sulphuric acid. This preparation, **2**, weighed 80 grams. The aqueous washings of **2** were made clear by adding a little salt and then dialyzed. After two days the precipitate which separated was filtered out, washed with water and with alcohol, giving preparation **3**, weighing 5.43 grams. The dialyzed solution from which **2** had separated contained very little proteid. The solution from which **2** had been originally separated by dilution was cooled over night to 7° and decanted from the precipitate that resulted, which formed a transparent layer of thick viscid fluid, as does legumin under similar conditions. This substance was treated with water, which rendered it opaque with separation of a white solid. After thoroughly washing with water the latter was dehydrated with absolute alcohol and dried over sulphuric acid, giving 20 grams of preparation **4.** The solution decanted from **4,** measuring 1650^{cc}, was treated with 2000^{cc} of water and, after standing at rest for about five hours, was poured off from a semi-fluid deposit. This, after thoroughly washing with water and alcohol and drying, gave 18.76 grams of preparation **5.**

The solution decanted from **5** was cooled to 5° for about 18 hours, but as very little proteid separated it was dialyzed for two days and then filtered from a small precipitate. The latter, washed with water and alcohol and dried over sulphuric acid, gave 5.37 grams of preparation **6.**

A part of preparation **2** was mixed with 0.5 per cent. sodium carbonate solution, in which it was mostly soluble, and the resulting solution was neutralized with dilute acetic acid. Salt in substance was then added, whereby the neutralization precipitate partially redissolved. The insoluble substance was filtered out and the clear filtrate dialyzed for 48 hours. The proteid separated in spheroidal form and was filtered out, washed with water and with alcohol, making preparation **7.**

A portion of preparation **4** was suspended in water and mostly dissolved by help of a little acetic acid. Dilute sodium carbonate solution was added until the proteid appeared to be completely precipitated, leaving the liquid distinctly acid to litmus. Salt in substance was added, which gave a nearly complete solution of the precipitate. The solution was filtered and dialyzed for four days, when the precipitated globulin was filtered out, washed and dried, giving preparation **8.**

Another preparation was made from a neutralized extract, by treating 200 grams of meal with 2 liters of 5 per cent. salt solution to which had been added a quantity of baryta, previously determined to be sufficient to make the resulting extract neutral to litmus.

The mixture was strained through fine bolting cloth and allowed to settle over night, but the suspended matter separated very imperfectly. The extract was then filtered on a pulp filter with a pump, and 1500^{cc} of a very nearly clear solution obtained, which was much less opalescent than any previously made from unneutralized extracts. This was saturated with ammonium sulphate and the resulting precipitate dissolved in water; the solution obtained was filtered perfectly clear and dialyzed for three days. The contents of the dialyzer were then filtered and the precipitate was washed with water. A portion of this substance was used to determine the reactions of this proteid and the remainder was washed with alcohol and dried, forming preparation 9.

All the preparations thus described were then dried to constant weight at 110° and analyzed with the following results:

GLYCININ: GLOBULIN OF YELLOW SOY BEAN.

	1	2	3	4	5	6	7	8	9	Average.
C	52.04	51.73	51.84	51.94	51.90	51.75	51.65	51.71	52.12	51.85
H	7.06	6.74	6.89	6.93	7.03	6.90	6.97	6.82	6.93	6.92
N	17.14	17.72	17.46	17.52	17.44	17.03	17.63	17.57	17.53	17.45
S	0.77	0.76	0.79	0.73	0.66	0.67	0.66	0.61	0.79	0.72
O	22.99	23.05	23.02	22.88	22.97	23.65	23.09	23.29	22.63	23.06
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Ash	0.34	0.57	0.43	0.53	0.41	0.30	1.34	0.61	0.38	

With the exception of the figures for nitrogen in the crude globulin, **1**, and in the final small fraction, **6**, these analyses are in close accord and give no evidence of any fractional separation. It is probable, therefore, that we have here a definite proteid, distinct from legumin, containing 0.50 per cent. less nitrogen and 0.30 per cent. more sulphur than that substance. We propose for this globulin the name *Glycinin.* Its reactions, determined by an examination of preparation **9**, are as follows:

In sodium chloride solutions it is readily soluble and is precipitated by dialysis, by dilution and by cooling.

By dialysis or by cooling it separates in the form of spheroids which, according to circumstances, after settling from the solution, either unite to a more or less coherent mass or else form a clear, transparent, viscid fluid, which, like legumin under similar conditions, is rendered white and solid by treating with water.

Solutions containing more than two per cent. of sodium chloride dissolve glycinin freely; the solvent power of those containing less salt diminishes more rapidly than the percentage of salt decreases.

Dissolved in sodium chloride solution, glycinin is not precipitated by saturating with magnesium sulphate or sodium chloride, but is completely precipitated by saturating with sodium sulphate at 34°.

In pure water, glycinin, when prepared from carefully neutralized extracts, is not soluble.

If soy bean meal is treated with water, upwards of 16 per cent. of this globulin is dissolved, but in this case the solution is doubtless due to the potassium phosphates contained in the seed, as was pointed out in our paper on legumin.

Dissolved in ten per cent. sodium chloride solution, glycinin is not coagulated even by prolonged heating in a boiling water-bath. By dilute acetic acid a precipitate is formed insoluble in excess of salt solution. If, however, glycinin be dissolved in a solution containing but little salt, the precipitate produced by acetic acid is soluble in a slight excess of either acid or salt. The insoluble, so-called albuminate form of this globulin, like that of legumin, when treated with salt solution becomes gelatinous and it is impossible to filter solutions containing even a small quantity of it.

In absence of salts, glycinin is readily soluble in quite dilute acetic acid and is precipitated from such solution by sodium carbonate, even before the acid is wholly neutralized. When the acid is completely neutralized the precipitate obtained is entirely soluble in brine. Dissolved in ten per cent. sodium chloride solution, glycinin is precipitated by tannic acid and by picric acid, the latter yielding a precipitate soluble in an excess of salt solution if too much picric acid be not present. With mercuric chloride no precipitate is produced.

With Millon's, Adamkiewic's, the biuret and xanthoproteic tests the usual proteid reactions result.

The solution A, page 375, which, as described, had been filtered from the globulin precipitated by dialyzing the solution of the ammonium sulphate precipitate of the total proteids of the extract, contained the remaining proteids extracted from the beans. This solution was saturated with ammonium sulphate, the precipitate so produced was filtered out and dissolved in a small quantity of water. After filtering clear, the solution was dialyzed for eight days. The globulin, which separated in well formed spheroids, when washed and dried weighed 20.0 grams, preparation **10.** The filtrate from **10** was saturated with ammonium sulphate, the precipitate dissolved in a little water, filtered clear and dialyzed for five days; a small deposit appeared which when washed and dried weighed 2.71 grams, preparation **11.** The solution filtered from **11** was returned to the dialyzer and, as nothing more separated after 48 hours, the dialyzer was transferred to alcohol. During the next 48 hours a considerable precipitate formed which when washed with alcohol and dried weighed 11.5 grams. Of this substance 7.5 grams were treated with water and the insoluble part was thoroughly washed with water and alcohol and dried. Preparation **12** was thus obtained, weighing 4.7 grams. The filtrate, from the precipitation of this substance by dialysis in alcohol, was mixed with a large excess of alcohol and the precipitate caused thereby was filtered out, dehydrated with absolute alcohol, dried and found to weigh 1.4 grams, preparation **13.** These preparations were dried at 110° and analyzed with the following results:

	10	11	12	13
Carbon	51.94	52.00	53.06	48.76
Hydrogen	6.88	6.83	6.94	6.28
Nitrogen	16.51	16.36	16.14	16.14
Sulphur	0.60	24.81	1.17	28.82
Oxygen	24.07		22.69	
	100.00	100.00	100.00	100.00
Ash	0.39	0.19	0.54	1.35

Of these preparations **10** and **11** have nearly the composition of phaseolin, but whether they are identical with that globulin could not be ascertained because they had become so largely coagulated by washing with alcohol and drying, that their reactions could not be satisfactorily determined.

A small quantity of globulin was obtained by further dialyzing the filtrate from preparation **9**, page 377, which, when dissolved in ten per cent. salt solution, became turbid at about 95°, and after continued heating at 99°, gave a considerable coagulum. Hydrochloric or acetic acid added to its solution in ten per cent. brine gave no precipitate and dilution with water gave a precipitate only when carried to a great extent. These reactions are characteristic of phaseolin, and taken in connection with the analyses of the similarly obtained preparations **10** and **11,** make it probable that these seeds contain a small proportion of phaseolin.

Preparation **12** has the composition of legumelin, which we have obtained in the same manner from a number of other leguminous seeds.

Preparation **13** is proteose.

Soy bean. (*Kiyusuki diadzu.*)

Fine flour made from this variety of the soy bean was first treated with petroleum benzine and obtained nearly free from fat. By extracting 2000 grams of the flour, thus prepared, with brine and proceeding in exactly the same manner as in making preparation **1** from the yellow soy bean, a large precipitate of globulin was obtained, a part of which when washed and dried, gave preparation **14**, weighing 25.0 grams. The remainder of the globulin was drained on filters, suspended in water and 300^{cc} of ten per cent. sodium chloride solution added, bringing the volume to 1000^{cc}. Under this treatment very nearly all dissolved. An equal volume of water was then added to the solution and the separated globulin allowed to settle. The precipitate was collected on a filter and redissolved in ten per cent. brine. The solution was filtered perfectly clear and dialyzed for 48 hours. The precipitate, so separated, was washed with water and with alcohol and dried, giving preparation **15**, weighing 83.5 grams. The solution filtered from the first precipitation of **15**, caused by dilution, as just described, was cooled to 8° during 24 hours. The substance thus separated, which formed a clear semi-fluid layer at the bottom of the jar, was thoroughly washed with water and with alcohol and dried. It weighed 12.85 grams and formed preparation **16**.

After drying at 110° to constant weight, these preparations were analyzed as follows:

GLYCININ.

	14	**15**	**16**	**Average.**
Carbon	51.80	52.15	52.09	52.01
Hydrogen	6.93	6.87	6.86	6.89
Nitrogen	17.45	17.48	17.47	17.47
Sulphur	0.75	0.72	0.70	0.72
Oxygen	23.07	22.78	22.88	22.91
	100.00	100.00	100.00	100.00
Ash	0.39	0.42	0.28	

These results agree well with those obtained from the yellow soy bean.

GLYCININ.

	Yellow Soy bean.	Kiyusuki diadzu Soy bean.
Carbon	51.85	52.01
Hydrogen	6.92	6.89
Nitrogen	17.45	17.47
Sulphur	0.72	0.72
Oxygen	23.06	22.91
	100.00	100.00

CONCLUSION.

The soy bean contains as its chief proteid constituent *glycinin*, a globulin similar in properties to legumin, but of somewhat different composition, containing nearly twice as much sulphur, four-tenths per cent. more carbon and one-half per cent. less nitrogen.

We give as the composition of this proteid the results of our analysis of preparation 9, which was obtained from a neutral and perfectly clear extract, for we believe that this represents more accurately the true composition of glycinin than the average of all the preparations.

GLYCININ.

Carbon	52.12
Hydrogen	6.93
Nitrogen	17.53
Sulphur	0.79
Oxygen	22.63
	100.00

The soy bean contains a more soluble globulin which resembles phaseolin in composition, and, so far as we could ascertain, also in its reactions. The amount of this proteid is small and the evidence that it is in reality phaseolin was not wholly satisfactory.

Besides these globulins about 1.5 per cent. of the albumin-like proteid *legumelin* was obtained. We have found legumelin in a number of other leguminous seeds, the pea, vetch, horse bean, lentil, adzuki bean and cow pea. The properties of legumelin are given in our paper on "Legumin and other Proteids of the Pea, Lentil, Horse bean and Vetch," page 370. The composition of legumelin as found in the soy bean is as follows:

LEGUMELIN.

Carbon	53.06
Hydrogen	6.94
Nitrogen	16.14
Sulphur	1.17
Oxygen	22.69
	100.00

A small quantity of proteose was also obtained from the soy bean, having the following composition:

PROTEOSE.

Carbon	48.76
Hydrogen	6.28
Nitrogen	16.14
Sulphur Oxygen	28.82
	100.00

Owing to the small amount of proteose no evidence was obtained as to the purity or individuality of this preparation.

TESTS OF THE VITALITY OF VEGETABLE SEEDS.

By E. H. Jenkins.

Every year since its organization in 1877 this Station has examined various vegetable and grass seeds with reference to their vitality and freedom from admixture with foreign seeds, in the interest both of buyers and sellers of seed in the State. Account of this work may be found in the Reports for 1877, p. 47; 1879, p. 121; 1880, p. 97; 1882, p. 93; 1883, p. 96, and 1884, p. 119. Of late the amount of work done has gradually increased, but no detailed account of it has been given in our Reports.

In November, 1896, the subject of seed testing was discussed by the Association of American Agricultural Colleges and Experiment Stations, and a committee of experts in seed testing was appointed to devise a standard form of seed-testing apparatus and method of procedure for use in all American Stations. This committee, consisting of G. H. Hicks, Div. of Botany, U. S. Department of Agriculture; Prof. Gerald McCarthy, North Carolina Station; Prof. F. W. Card, Nebraska Station; Prof. W. R. Lazenby, Ohio State University, and E. H. Jenkins, Connecticut Station, reported a set of rules for seed sampling and testing which was adopted by the Association of Agricultural Colleges and Stations, and has been published as circular No. 34 of the Office of Experiment Stations.

A form of apparatus was also adopted for use by the Stations. It is believed that by close adherence to the methods prescribed, and by using the standard form of apparatus, uniform and accurate results may be obtained by all who engage in this kind of work.

Since November, 1896, six hundred and fifty-five samples of seeds, chiefly of vegetables, have been examined as to their vitality. This work was done for purchasers of seed and also for seed growers and seed dealers within the State.

The methods adopted by the Association have been strictly followed, and the germinating chambers described in the committee's report have been used.

The work has been wholly done by Mr. Lange.

A following table presents the average, maximum and minimum vitality of all the samples tested at this Station by the newly adopted methods. The age of the seed is that reported by the seedsmen or growers who sent the samples.

GERMINATION TESTS OF VEGETABLE SEEDS.

	Age of Seed in years, when tested.	No. of Samples.	Average Percentage by number of seed Sprouting.	Maximum.	Minimum.
Beans	1–2	4	93.5	98.0	90.0
	2–3	6	83.8	97.0	59.0
Beets	0–1	13	175.0	211.0	119.0
	1–2	10	188.0	230.0	157.0
	2–3	3	171.0	192.0	159.0
Brussels Sprouts	3–4	1	36.0	....	....
Buckwheat		1	99.0	....	....
Cabbage	0–1	11	79.7	94.0	44.0
	1–2	6	84.2	96.5	47.5
	2–3	3	71.5	88.0	43.0
	3–4	2	84.2	91.5	77.0
Carrot	0–1	15	59.4	77.0	35.0
	1–2	6	62.8	91.3	32.3
	2–3	2	38.3	45.5	31.0
Cauliflower	0–1	1	84.5	....	....
	1–2	3	38.7	46.8	27.5
Celery	0–1	17	68.0	83 5	38.3
	1–2	1	49.0	....	....
	2–3	8	60.5	79.3	22.0
	3–4	5	55.4	63.5	27.3
Corn, Sweet	0–1	2	98.5	99.0	98.0
	1–2	13	74.5	98.0	37.5
Cress	0–1	3	61.5	91.3	35.5
Cucumber	0–1	10	86.3	99.0	57.0
	1–2	6	86.0	95.5	67.5
	4–5	1	79.0	....	....
Dandelion	0–1	1	70 3	....	....
Egg Plant	0–1	1	40.0	....	....
Kale		3	85.5	92.0	78.3
Kohl Rabi		2	90.1	93.5	86.8
Leek	0–1	3	84.5	86.0	83.5
	1–2	1	74.0	....	....
	2–3	1	35.5	....	....
Lettuce	0–1	20	95.9	100.0	64.5
	1–2	16	89.7	100.0	53.3
	2–3	9	84.7	98.8	23.8
	5–6	1	10.3	....	....
Mangel Wurzel	0–1	2	190	203	177
	1–2	3	153	176	138
	2–3	3	131	181	101
Musk Melon	0–1	8	75.4	100.0	28.0
	1–2	8	72 3	96.5	48.0
Onion, Connecticut grown	0–1	87	74.7	97.5	36.8
	1–2	28	54.2	91.5	0.8
	2–3	3	18.4	33.0	8.8
California grown	0–1	17	93.8	97.5	88.5
	1–2	6	85.4	98.0	58.5
	2–3	2	85.1	91.5	88.8
Parsley	1–2	3	39.8	72.0	7.8
Parsnip	0–1	3	58.5	63.5	50.5
	1–2	2	22.7	42.8	2.5
	2–3	1	30.3	....	....
Pepper	0–1	4	76.6	89.5	61.0
	1–2	1	29.3	....	....

	Age of Seed in years, when tested.	No. of Samples.	Average Percentage by number of seed Sprouting.	Maximum.	Minimum.
Pumpkin	0–1	5	70.7	95.0	40.0
Radish	0–1	12	85.1	99.8	72.0
	1–2	9	59.4	85.0	31.0
	2–3	7	38.0	55.5	22.5
Salsify	0–1	1	80.5	....	....
Spinach	0–1	9	85.5	89.7	72.0
	1–2	1	72.0	....	....
Squash	0–1	12	84.9	100.0	68.8
	1–2				
Tobacco	0–1	2	65.5	87.0	44.0
Tomato	0–1	5	92.6	97.0	86.8
	1–2	3	92.2	93.5	90.5
	2–3	1	65.5	....	....
	3–4	3	70.2	96.2	43.5
Turnip		2	92.0	100.0	84.0
Watermelon	0–1	7	82.7	100.0	56 3
	1–2				
	2–3	7	43.5	81.0	0.0

The "percentage" of beet seed sprouting, as given in the table, is nearer 200 than 100. To test the vitality of beet seed one hundred "seeds" are put in the germinating apparatus and all the sprouts are counted. As each beet "seed" is a fruit which may contain from two to six separate seeds, it is evident that the possible number of sprouts may be 600. To count the actual number of seeds in the one hundred fruits examined, which would make a true percentage statement of sprouting power possible, would be extremely laborious; but the form of statement here followed is sufficiently intelligible and is justified by usage.

It will be noticed that on the average, the samples of beet, cabbage and carrot seed which were over a year old had a higher sprouting capacity than new seed. This is no doubt due to the generally better quality of the 1896 seed. The results of several years' tests would probably show that taking one year with another a larger percentage of new seed will sprout than of seed a year older.

Onion Seed.

Since November 1st, 1896, the Station has examined 131 samples of onion seed, of the crops of 1896 and 1897, raised in Connecticut, Rhode Island and California.

These samples, accompanied by statements regarding variety, age of seed, place where grown, etc., were sent by seed growers and wholesale dealers.

The results of these tests are given in detail in the following table and are here briefly summarized.

1. *Vitality of Onion Seed as Affected by Age of Seed.*

In the samples examined, the percentage by number of seed which sprouted was as follows:

	Conn. grown.		Cal. grown.	
	No. of Samples.	Per cent. Sprouted.	No. of Samples.	Per cent. Sprouted.
Seed stated to be less than 1 year old	87	74.7	17	93.8
" " between 1 and 2 yrs. old	28	54.2	6	85.4
" " " 2 " 3 "	3	18.4	2	85.1

While as a rule the vitality of seed decreases with age, it is also true that in some cases seed which is two years old will sprout better than seed of the new crop.

In several cases given in the table, Connecticut seed between one and two years old sprouted to the extent of more than 90 per cent. while the average for new crop seed is less than 80 per cent.

Comparison of the Crops of Onion Seed in 1896 and 1897 in Connecticut.

Forty-four samples of the crop of 1896, tested within a few months after it was harvested, had an average of 72.4 per cent. of seed which sprouted. Thirty-nine samples of seed from crops of 1897 had an average of 77.9 per cent. of seed which sprouted.

The average sprouting capacity of Connecticut grown onion seed, as determined for a number of years at this Station, has been as follows:

	No. of Samples tested.	Average Percentage Sprouted.
In 1880	14	87.0
1894	25	82.9
1895	13	85.5
1896	44	72.4
1897	39	77.9

California grown Onion Seed.

California-grown onion seed had, as a rule, a considerably higher percentage of seed capable of sprouting than the Connecticut-grown.

The average of 16 tests of crops raised in 1897 was 93.7 per cent.

The California seed is considerably lighter than Connecticut grown. Tests made at this Station, and published in the Report for 1883, p. 99, show that the average weight of 1000 seeds of Wethersfield large red onion, Connecticut grown, in 16 trials, was 3.95 grams; Michigan grown, 3 trials, 4.16 grams; California grown, 3 trials, 2.95 grams. White Portugal onion, Connecticut grown, 4 trials, 3.901 grams; California grown, 3 trials, 2.818 grams. Danvers yellow onion, Connecticut grown, 11 trials, 3.786 grams; New York grown, 5 trials, 4.236 grams; California grown, 3 trials, 3.234 grams, etc.

Number of Seed in a Pound of Onion Seed.

In 79 trials, published in the Report for 1883, p. 99, there were found :

Average number of Onion Seed per pound	12,000
Maximum " " " "	17,400
Minimum " " " "	10,000

The Sprouting Capacity of Different Varieties.

The average sprouting capacity of four varieties, of which a considerable number of samples has been tested, is as follows :

Variety.	No. of Samples Tested.	Average Percentage of Sprouting Seed.
Yellow Globe............	55	79.6
Red Globe..............	32	79.3
White Globe............	27	77.7
White Portugal	20	67.3

The percentage of three of the varieties is essentially the same, but the White Portugal has shown a decidedly smaller sprouting capacity in these tests by fully twelve per cent.

GERMINATION TESTS OF ONION SEED, RAISED IN CONNECTICUT.

Variety.	Station No.	Age of Seed, in years, when tested.	Percentages of Seed, by Number.			No. of Days within which one-half of the Sprouting Seed Germinated.
			Sprouted in 14 days.	Remained Hard.	Decayed.	
Yellow Globe, Crop of 1895..	971	1–2	87.5	7.3	5.2	6
	988	1–2	63.0	15.5	21.5	3
	991	1–2	55.0	12.5	32.5	5
	1054	1–2	0.8	64.9	34.3	
	1071	1–2	89.5	7.5	3.0	4
	1208	1–2	9.0	59.0	32.0	5
	1209	1–2	14.5	57.2	28.3	6
	1210	1–2	28.5	55.5	16.0	5
	1213	1–2	67.0	25.5	7.5	4
	1565	2–3	8.8			5
	1566	2–3	33.0			5
	1567	2–3	13.5			5
Yellow Globe, Crop of 1896..	970	0–1	92.5	2.5	5.0	3
	972	0–1	55.0	10.0	35.0	6
	973	0–1	93.8	5.0	1.2	3
	974	0–1	85.0	7.5	7.5	3
	976	0–1	93.0	4.8		5
	977	0–1	66.0	19.8	14.2	3
	978	0–1	91.0	6.5	2.5	3
	979	0–1	61.0	11.0	28.0	3
	1044	0–1	75.0	21.3	3.7	6
	1050	0–1	68.5	30.8	0.7	6
	1068	0–1	83.5	10.8	5.7	3
	1072	0–1	84.5	6.0	9.5	6
	1121	0–1	84.8	10.0	5.2	3
	1122	0–1	84.0	10.3	5.7	3
	1123	0–1	70.8	10.5	18.7	3
	1124	0–1	88.2	3.8	8.0	3
	1211	0–1	72.0	15.0	13.0	3
	1212	0–1	70.3	25.5	4.2	3
	1562	1–2	69.3	5.5	25.2	4
Yellow Globe, Crop of 1897..	1230	0–1	96.8	1.2	2.0	3
	1300	0–1	72.8	18.5	8.7	4
	1301	0–1	67.3	20.0	12.7	4
	1302	0–1	76.5	14.0	9.5	4
	1303	0–1	79.0	11.0	10.0	4
	1315	0–1	63.8	4.8	31.4	3
	1316	0–1	77.0	2.5	20.5	2
	1328	0–1	97.5	0.3	2.2	3
	1329	0–1	61.8	3.0	35.2	3
	1429	0–1	78.0	1.5	20.5	3
	1496	0–1	71.0	17.5	11.5	3
	1497	0–1	60.0	22.5	17.5	3
	1602	0–1	72.0	15.8	12.2	3
	1603	0–1	77.3	14.5	8.2	3
	1604	0–1	72.5	16.0	11.5	3
	1605	0–1	77.5	15.5	7.0	3
	1623	0–1	81.0	6.5	12.5	3
	1624	0–1	83.5	7.0	9.5	3
	1625	0–1	78.5	4.0	17.5	3

GERMINATION TESTS OF ONION SEED, RAISED IN CONNECTICUT.—*Continued.*

Variety.	Station No.	Age of Seed, in years, when tested.	Percentages of Seed, by Number.			No. of Days within which one-half of the Sprouting Seed Germinated.
			Sprouted in 14 days.	Remained Hard.	Decayed.	
Red Globe, Crop of 1896	982	0–1	82.0	12.0	6.0	3
	983	0–1	40.5	33.8	25.7	5
	1045	0–1	82.0	10.8	7.2	3
	1047	0–1	81.5	9.3	9.2	3
	1051	0–1	68.5	30.8	0.7	
	1052	0–1	63.3	34.8	1.9	
	1119	0–1	90.7	3.8	5.5	3
	1120	0–1	92.5	2.5	5.0	2
	1125	0–1	90.3	4.3	5.4	3
	1309	1–2	74.3	15.8	9.9	3
Red Globe, Crop of 1897	1229	0–1	66.5	4.5	29.0	2
	1304	0–1	73.3	5.0	21.7	4
	1305	0–1	84.2	2.8	13.0	4
	1306	0–1	83.3	4.5	12.2	4
	1307	0–1	84.3	3.0	12.7	4
	1528	0–1	79.8	1.3	18.9	3
	1601	0–1	82.3	4.0	13.7	3
Wethersfield Red, Crop of 1895	990	1–2	5.0	73.8	21.2	5
	1215	1–2	43.3	36.8	19.9	4
	1216	1–2	27.2	39.7	33.1	5
Wethersfield Red, Crop of 1896	975	0–1	82.0	9.3	8.7	3
	1214	0–1	36.8	47.5	15.7	3
	1217	0–1	58.5	28.3	13.2	3
	1218	0–1	54.7	15.8	29.5	3
	1238	1–2	50.5	21.5	28.0	3
	1532	1–2	73.5	9.8	16.7	3
Wethersfield Red, Crop of 1897	1227	0–1	55.0	8.3	36.7	3
Early Red Flat, Crop of 1896	987	0–1	61.5	19.5	19.0	2
	1312	1–2	59.0	25.1	15.9	4
Early Red Flat, Crop of 1897	1530	0–1	90.3	1.5	8.2	4
White Globe, Crop of 1895...	984	1–2	75.0	17.3	7.7	5
	985	1–2	58.5	22.5	19.0	5
	1204	1–2	47.2	32.8	20.0	4
	1205	1–2	29.5	29.5	41.0	5
White Globe, Crop of 1896...	986	0–1	83.8	7.3	8.9	2
	1046	0–1	66.5	10.8	22.7	4
	1048	0–1	63.0	14.8	22.2	3
	1049	0–1	70.0	11.5	18.5	4
	1126	0–1	96.0	2.5	1.5	3
	1206	0–1	61.3	17.0	21.7	3
	1207	0–1	44.2	35.5	20.3	4
	1239	1–2	84.0	6.3	9.7	3
	1310	1–2	59.8	13.0	27.2	4
	1311	1–2	79.5	14.0	6.5	3
	1563	1–2	80.8	4.3	14.9	3
	1564	1–2	91.5	4.5	4.0	3

GERMINATION TESTS OF ONION SEED, RAISED IN CONNECTICUT.—*Continued.*

Variety.	Station No.	Age of Seed, in years, when tested.	Percentages of Seed, by Number.			No. of Days within which one-half of the Sprouting Seed Germinated.
			Sprouted in 14 days.	Remained Hard.	Decayed.	
White Globe, Crop of 1897...	1228	0–1	82.5	2.5	15.0	3
	1240	0–1	85.5	3.0	12.0	3
	1296	0–1	85.0	6.0	9.0	4
	1297	0–1	79.0	9.5	11.5	4
	1298	0–1	72.3	12.3	15.4	4
	1299	0–1	73.5	10.0	16.5	4
	1498	0–1	72.3	14.8	12.9	3
	1499	0–1	71.8	13.8	14.4	3
	1606	0–1	72.5	9.2	18.3	3
	1607	0–1	79.3	9.3	11.4	3
White Portugal, Crop of 1895	1219	1–2	34.8	30.0	35.2	5
White Portugal, Crop of 1896	981	0–1	68.5	9.5	22.0	3
	1220	0–1	66.5	15.7	17.8	3
	1221	0–1	42.8	3.0	54.2	4
	1222	0–1	43.0	8.0	49.0	4
	1223	0–1	46.8	15.7	37.5	3
	1224	0–1	62.0	18.8	19.2	3
	1225	0–1	68.8	20.1	11.1	4
	1226	0–1	57.8	22.1	20.1	3
	1308	1–2	58.5	8.3	33.2	3
White Portugal, Crop of 1897	1589	0–1	81.5	2.0	16.5	3
Yellow Cracker, Crop of 1896	1073	0–1	71.7	14.5	13.8	4

GERMINATION TESTS OF ONION SEED RAISED IN CALIFORNIA.

Kind of Seed.	Station No.	Age of seed in years, when tested.	Percentages of Seed, by Number.			Number of days within which one-half of the Sprouting Seed Germinated.
			Sprouted in 14 days.	Remained Hard.	Decayed.	
Prize taker, Crop of 1895....	989	1–2	58.5	39.0	2.5	7
Crop of 1896....	1313	1–2	85.5	4.3	10.2	4
	1314	1–2	93.0	2.0	5.0	3
Crop of 1897....	1428	0–1	97.0	0.3	2.7	4
Wethersfield Red, Crop of 1896	1529	1–2	98.0	0.5	1.5	2
Crop of 1897	1592	0–1	95.5	0.3	4.2	3
Red Globe, Crop of 1897	1322	0–1	96.0	0.3	3.7	3
	1323	0–1	95.0	1.0	4.0	3
	1324	0–1	96.0	1.0	3.0	3
	1325	0–1	97.5	1.0	1.5	3
	1326	0–1	93.8	1.5	4.7	3
White Portugal, Crop of 1895	980	1–2	81.5	8.1	10.4	3
Crop of 1896	1531	1–2	95.8	1.3	2.9	3
White Silverskin, Crop of 1897	1590	0–1	94.0	0.5	5.5	3
Yellow Globe, Crop of 1895..	1525	2–3	88.8	2.8	8.4	4
	1533	2–3	91.5	3.8	4.7	4
Crop of 1897..	1318	0–1	90.5	0.5	9.0	3
	1319	0–1	88.5	0.5	11.0	3
	1320	0–1	92.7	0.5	6.8	3
	1321	0–1	89.0	1.0	10.0	3
	1327	0–1	93.5	2.8	3.7	3
	1524	0–1	90.8	0.8	8.4	3
	1591	0–1	92.5	1.8	5.7	4
Yellow Cracker, Crop of 1897	1317	0–1	97.5	0.0	3.0	3
Yellow Strasburg, Crop of 1897	1593	0–1	94.8	0.5	4.7	3

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